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Editorial Secretary, — H. PLATT, M.S., F.R.C.S., 26 St. John Street, Manchester, England.

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R. C. ELMSLIE, M.S., F.R.C.S.
E. W. HEY GROVES, M.S., F.R.C.S.

For the American Orthopedic Association

Editor,—E. G. BRACKETT, M.D.
166 Newbury Street, Boston.

Committee,—
J. L. PORTER, M.D.
R. B. OSGOOD, M.D.
W. W. PLUMMER, M.D.

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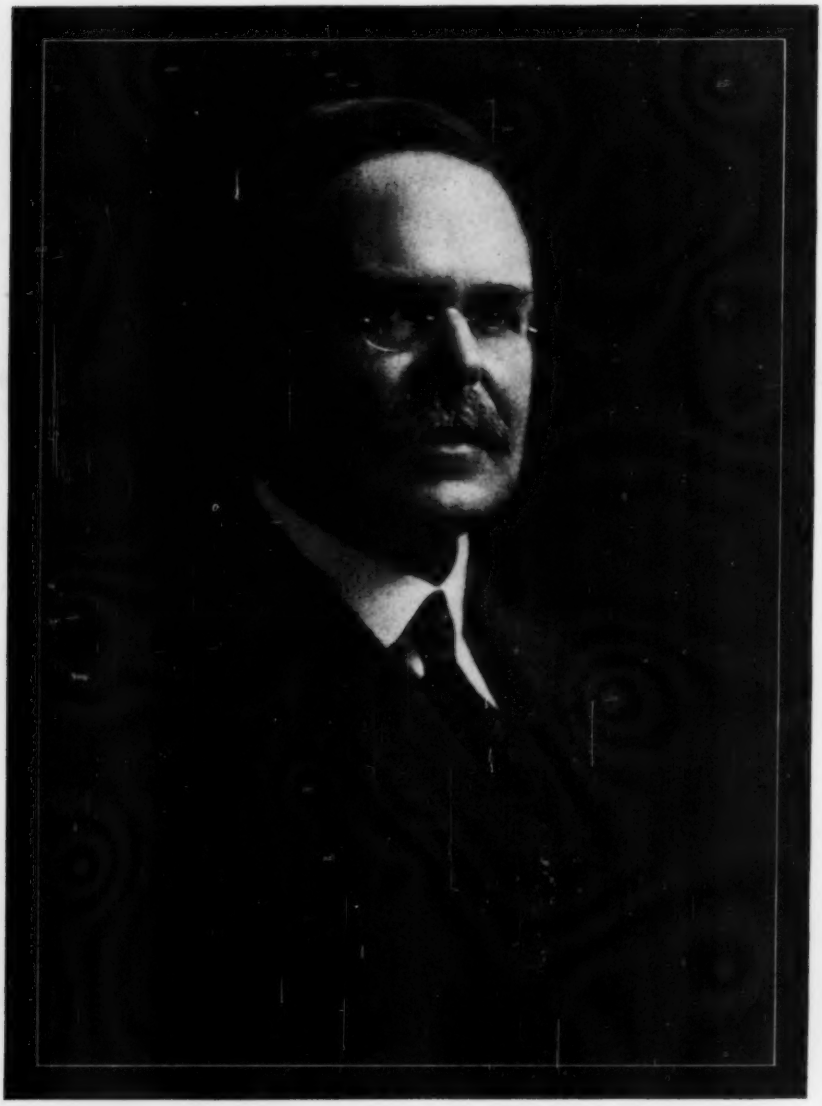

Henry Ling Taylor, M.D.
1856-1923

Vol. V, No. 4 OCTOBER, 1923 Old Series: Vol. xxi, No. 4

The Journal of Bone & Joint Surgery

HENRY LING TAYLOR, M. D.

Henry Ling Taylor, one of New York's foremost orthopaedic surgeons, died at his home in Montclair, N. J., June 9, 1923, after an illness of several months' duration. Dr. Taylor's death closed a career which was characterized by unswerving devotion to the highest ideals in both his personal and professional life and he will be remembered as a man of simple tastes, content to labor in his chosen field without thought of self-aggrandizement, seeking only the interests of those whom he was called upon to serve.

He was particularly interested in the younger generation of the profession, and many men who have gained prominence in their specialty owe their opportunity to prove their worth to Dr. Taylor's influence and wise counsel.

Born March 17, 1856, in New York, Henry Ling Taylor was educated in private schools of his native city and Hanover, Germany, and graduated with high honors from Yale, Class of '77. He prepared for his medical work at the College of Physicians and Surgeons, New York, graduating in 1881 at the head of his class. After studying in the best clinics abroad he settled in New York to assist his father, Dr. Charles Fayette Taylor, one of the pioneers of orthopaedic surgery. He was for many years professor of orthopaedic surgery at the New York Post-Graduate Hospital and School, attending surgeon to the Hospital for Ruptured and Crippled, consulting orthopaedic surgeon to Mountainside Hospital, Montclair, N. J., a Fellow of the American College of Surgeons, past president and member of the

American Orthopedic Association, member of the New York Academy of Medicine, the American Medical Association, the New York County Medical Society, the Northwestern Medical Society, one of the founders of the American Posture League, of which he was secretary, and one of the founders of the New York Physical Education Society. He contributed generously to the literature on orthopaedic surgery and was the author of a standard textbook on the subject.

In 1890 Dr. Taylor married Margaret Brodt of Dansville, N. Y., who survives him, as do their four sons.

In the passing of Henry Ling Taylor the medical profession loses one of its finest characters, whose exemplary life cannot fail to leave an enduring impression on those who were fortunate enough to know him intimately.

P. W. R.

INTERNAL DERANGEMENTS OF THE KNEE.

A Review of the Subject With a Report Based on 181 Operated Cases.

From the Orthopaedic Clinic of the Massachusetts General Hospital, Boston, Mass.

BY J. K. SURLS, M.D., AND R. B. OSGOOD, M.D., BOSTON.

FOREWORD

Since Dr. E. A. Codman has stimulated end result study, more of these helpful analyses have been attempted and a clearer evaluation of methods of treatment has been gained thereby. Many of these end result studies have seemed to us to lack conclusiveness for several reasons:

1. They do not cover a sufficient period of time.
2. They have not included a sufficient number of cases.
3. The "follow-up" has not been prosecuted with sufficient energy to secure a high percentage of end results of the given series.
4. The analyses have not been made under a sufficient number of headings to make possible a fair interpretation of the findings.

In short, the studies have often seemed to lack a thoroughness of search and have been inconclusive as to the true meaning of the results. The ability to draw rational conclusions which may guide future treatment, alone can justify the considerable labor and expense which any extensive end result study entails.

It was with the purpose of ascertaining how complete an end result study could be made without padding or unprofitable detail that the present one was undertaken. If it should be found fairly complete and inclusive, the credit for it must be given to Dr. Surls, who in the busy life of an interne has found time to follow up and record a large percentage of the cases seen in a floating hospital clinic. His is also the careful analysis of the findings from the point of view of both patient and surgeon. All the laborious part of the work he has performed.

ROBERT B. OSGOOD, M. D.

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INTRODUCTION.

THE writers desire to lay stress on the fact that this paper is, in great part, a *review* of the subject and did not involve original work. They have listed their involuntary co-authors in the bibliography. They have not hesitated to borrow plumage from all available sources. The lineage of the hybrid creature so produced can easily be traced to clinic and laboratory both in this country and abroad.

References to other writers have been made as complete as possible. Their articles, listed in the bibliography, give important details of subjects necessarily summarized in our paper.

DEFINITION.

An internal derangement of the knee is a mechanical derangement, caused by a product of the joint itself and lying within the joint. The obstructing tissue may be the result of either a sudden or a slow process —an injury or a gradual degeneration of the tissues, or both combined.

A foreign body, such as a needle, may, of course, cause an internal derangement; but such cases are excluded by the above definition, in accordance with the general understanding of the term.

HISTORY.

Famous names are associated with one of the types of internal derangement—loose bodies. The condition is evident but the cause, obscure. The problem is therefore the sort to appeal to the active-minded surgeon seeking for ultimate causes.

Paré was the first to refer to loose bodies in the joints. In 1558 he successfully removed a loose body from the knee. In his writings, he included loose bodies under the heading of "Monstrosities." Alexander Monroe, in 1758, was the first to recognize that loose bodies might be derived from the articular ends of bones. John Hunter, one year later, recognized the occurrence of loose bodies from hypertrophic outgrowths in a knee which he had dissected. He investigated the subject of loose bodies during the last years of his life, and his observations were published by his brother-in-law in 1793, the year of Hunter's death.

These observations of Hunter were incorrect because of the erroneous pathology upon which he built them, and not because of illogical reasoning. He believed that extravasated blood, upon being organized, assumed the nature of whatever tissue lay adjacent to it, and explained the occurrence of cartilaginous bodies in the knee-joint in this way. Kölliker, in a later generation, discovered cartilage cells in the synovial villi, and with Rainey evolved the theory of loose bodies being produced from this tissue. We shall see later that these three men—Monroe, Hunter, and Kölliker—between them traced out the three main sources of loose bodies.

Because of the work of Kölliker and Rainey, the theory of the derivation of loose bodies from the articular surface fell temporarily into disfavor. Later investigation showed, however, that in many cases the body resembled a portion of the articular surface so closely that source therefrom could not be denied. Sir James Paget believed that no force could detach such pieces from living bone, and concluded that they were exfoliations of injured portions of the cartilage, after necrosis and without acute inflammation. König, although not denying a traumatic origin in some cases, considered that the majority were detached by a dissecting osteochondritis, but admitted that his examinations had revealed no trace of a morbid process.

Coming back to the years following Hunter's death, William Hey, of Hunter's own hospital—St. George's—carried on the work and in 1803 published his observations. He recommended the trial of a well-fitting kneecap before resorting to operation, because of the then-serious danger of joint infection. He coined the term "internal derangement of the knee-joint" and described the condition as he had seen it, because "he was not acquainted with any author who had described the disease or the remedy."

In his description of the reduction of a derangement he states that he grasped the thigh with one hand and the lower leg with the other. He then gradually extended the knee, and in the course of this extension

suddenly flexed it to the extreme. He says—"This operation I repeated once, and whatever may be the thought of my theory, my practice proved successful." If we could step backward through the interval of one hundred and twenty years, we might be able to supply him with the "thought of his theory." Hey's treatment of derangements was entirely non-operative and he failed to follow-up his reductions with prolonged immobilization, so essential in obtaining a satisfactory result. The introduction of aseptic surgery in 1840 reduced the danger of operative infection, but the inactive mode of life of the average individual of this period made knee derangements necessarily few.

D'Arcy Power, whose Hunterian lecture supplied part of the historical data given above, gives a graphic picture of the conditions during the Regency and early Victorian periods which held up for a time the development of this line of work. His point is that the Englishman of those periods did not put severe enough strain on his knees to displace a semilunar cartilage. The man-about-town played billiards and flexed his knee more severely at his favorite bar than anywhere else. The cricketer was not a very active athlete, when he wore a top hat as part of his costume. "Young ladies took only a minimum of exercise and considered it indelicate to have an appetite. They lounged and sewed, read novels and fainted on the slightest provocation."

The development of coal-mining, the rapid spread of all forms of athletics, and finally the Great War have all instituted a fresh assault upon the finely adjusted structures of the knee-joint. And so it came about that the surgeon again championed the cause of the deranged knee, and has been especially active since the year 1914. During the first decade of this century his fear of operative joint infection very properly dwindled, as he improved his technique and saw the good results obtained thereby. He thus had an unrestricted field of operation when the Great War threw its mass of knee cases upon his hands.

SURGICAL ANATOMY.

The description will be limited, as far as possible, to those structures involved in internal derangements.

Surface Anatomy.—With the knee flexed to a right angle, the patella stands out most prominently, and to either side of it are lesser projections—the femoral condyles. Below each condyle is a corresponding outflaring of the tibia—the tibial tuberosities. An inch and three-

quarters (4½ cm.) below the patella is the tibial tubercle, with the patellar tendon inserted into it.

On the external aspect of the knee is seen the prominence formed by the head of the fibula, with the tendon of the biceps running to it. In a corresponding position on the inner aspect of the knee, three tendons can be palpated. That of the semitendinosus is the most prominent. Between it and the inner femoral condyle are those of the gracilis and semimembranosus, the former lying between the other two. (The terms "mesial" and "lateral" are now being used to some extent for "internal" and "external," respectively.)

The joint line lies three-quarters of an inch (2 cm.) below the patella with the knee flexed to a right angle, and passes along the lower border of the depression seen on either side of the patellar tendon.

Type of Joint.—We conceive of the knee as a hinge joint modified in two ways: In the first place, there is a slight outward rotation of tibia on femur as the joint swings into full extension, thereby screwing the joint into a more stable structure than it would be otherwise. In this rotation, the external portion of the joint acts as the center, and the inner femoral trochlea describes an arc over the corresponding tibial surface. In the second place, some rotation, both internal and external, of tibia on femur is allowed in all positions of the joint except in the complete extension just described. Slight antero-posterior motion is also possible when the joint is flexed.

Capsule.—The capsule is a sleeve of fibrous tissue completely surrounding the joint, except posteriorly in the intercondyloid area, in which place it is deficient. The tibial attachment throughout, and the posterior portion of the femoral, lie close to the edge of the articulating surface. The anterior and lateral portions of the femoral attachment lie half an inch (1¼ cm.) or more above the margin of the articulating surface.

Supporting Structures.—The joint is supported on all four sides by ligaments, muscles, tendons, and their aponeurotic expansions.

On the internal aspect, and situated nearer the back than the front of the joint, is a broad, membranous band called the internal lateral ligament. It is attached above to the internal femoral condyle just below the adductor tubercle and below, to the internal condyle and adjacent surface of the tibia. It is intimately associated with the capsule and the internal semilunar cartilage. On the external aspect

of the joint is a round, fibrous cord called the long external lateral ligament. Its upper end is attached to the external femoral condyle and its lower, to the head of the fibula. These attachments lie nearer the back than the front of the joint, corresponding to the internal lateral in this respect. The ligament is not attached to the capsule nor to the external semilunar cartilage. Its fibular attachment lies between the halves of the insertion of the biceps. The short external lateral ligament is an inconstant bundle of fibres lying posterior and parallel to the long ligament, and with corresponding attachments. It is closely associated with the capsule.

On the posterior aspect of the joint is a strong sheet of tissue, stretched between femur and tibia and called the posterior ligament. Above, it is attached to the upper extremity of the intercondyloid fossa, and on both sides of the fossa is attached just outside the femoral articular surface, in conjunction with the joint capsule. Its tibial attachment, too, is blended with the joint capsule. It has a superficial portion derived from the tendon of the semimembranosus at its insertion. This bundle of fibers runs from the medial condyle of the tibia obliquely upward and outward to the lateral femoral condyle and is known as the posterior ligament of Winslow.

In front, the joint is supported by the patella and its tendon and the fibrous expansions derived from the vasti and lying on either side of the patella. On all its other aspects as well, the joint is thoroughly supported by muscles, tendons, and their expansions. The ham-strings, gracilis, sartorius, gastrocnemius, and popliteus all take part, but the quadriceps extensor plays a more prominent part than the rest.

Semilunar Cartilages.—Two functions—great strength and range of motion—are required in the knee joint, and it is because they tend to be mutually exclusive that a somewhat complicated mechanism is required. Nature's answer to this problem is the partial interposition, between the articulating bony surfaces, of two semilunar cartilages, so arranged that they slide centrally when the joint is flexed and peripherally when it is extended, thus keeping the articulating surfaces in contact at all times and thereby maintaining a stable joint.

The means by which they thus slide back and forth at the proper time is interesting: All four extremities of these cartilages are attached firmly near the middle line of the joint. The portions of the cartilages between these extremities, on the other hand, are attached to the joint capsule. By these means, there is a constant pull inwards on the part of the attached extremities and outwards by the intervening portions.

But the pull inwards is the stronger, and so the cartilages are held in apposition with the femoral articular surfaces. (Barker.)

If now, the quadriceps contracts, it extends the joint and at the same time draws the capsule tense. The capsule transmits this pull to the semilunars, and draws them out of harm's way as the joint is extended. And vice versa, when the quadriceps relaxes, it allows the knee to flex and the semilunars to slide centrally again. The attachment between capsule and semilunar is close to the tibial attachment of the capsule. The intervening portion of capsule is called the coronary ligament. It allows a slight range of motion on the part of the semilunars, in that they can be lifted a quarter of an inch (½ cm.) from the tibial surface.

The semilunars also perform another important function—that of a buffer when the femoral and tibial surfaces are pressed suddenly together. Structures performing a similar function are found in the other supporting joints—the cotyloid ligament in the hip, and the mortise formed by tibia and fibula in the ankle-joint.

It should be noted at this point, that the anterior extremity of the internal semilunar has a dual attachment: the outer portion is continuous with the transverse ligament—a band of tissue extending across to join the external semilunar; the inner portion is attached separately to the tibia. This point helps to explain longitudinal fractures of the cartilage.

Crucial Ligaments.—The crucial ligaments are short, thick ligaments running between femur and tibia, and performing several functions, the most prominent of which is antero-posterior stabilization. The anterior crucial is attached, at its lower extremity, to the anterior intercondylar area of the tibia and the adjacent portion of the tibial spine. It passes upward, backward, and outward, to be inserted far back in the intercondylar notch of the femur, on the internal surface of the external condyle, thus preventing anterior displacement of the tibia and helping to prevent hyperextension of the joint. (The two lateral ligaments are the other limiting structures.) The posterior crucial is attached, at its lower end, to the posterior intercondylar area of the tibia and to adjacent structures. It passes upward, forward, and inward, crosses the other crucial internal to it, and is inserted far forward in the femoral intercondylar notch on the outer surface of the inner condyle, thus preventing posterior displacement of the tibia.

The anterior crucial is especially tense in full extension, and the posterior in full flexion. In intervening degrees of flexion, both are

slightly relaxed. This explains the slight antero-posterior motion possible in moderate degree of flexion. But the crucials also aid in preventing lateral mobility and ab- and adduction. In abduction with the knee fully extended, the internal lateral ligament takes the full strain. With the knee moderately flexed, the anterior crucial receives some of it. In adduction, it is the external lateral ligament and posterior crucial that function. Both crucials play a part in limiting internal rotation, by pressure against each other at their point of crossing. (The other limiting structure is the internal lateral ligament.) They do not take part in limiting external rotation, which is governed by the lateral ligaments.

Tibial Spine.—The tibial spine should be described in connection with the anterior crucial ligament, because of its association with it in certain derangements. The spine is an intercondylar bony eminence with a prominent tubercle on either side. The inner of these tubercles gives attachment to fibers of the anterior crucial, and for this reason it may be avulsed when great stress is thrown upon the crucial.

Fat-pads.—The infrapatellar fat-pad requires mention because of its enlargement at times to pathological proportions. It lies beneath the patellar tendon, is of considerable size, and fills in the dead space in this portion of the joint. It functions as a cushion. Other, smaller fat-pads lie at different places in the joint and have a similar function. Fibres have been traced by Tenney from the alar ligaments into the infrapatellar fat-pad and are believed by him to pull up the pad on extension of the joint, thus keeping it from injury between the articulating surfaces.

Synovial Membrane.—This membrane invests the whole of the articular cavity. It is reflected over the semilunar cartilages, the infrapatellar fat-pad and the crucials on their anterior and lateral aspects. It does not extend around to the posterior surface of the posterior crucial. It is prolonged upward upon the anterior surface of the femur in the form of a pouch. This pouch is supported, during extension of the knee, by the subcrureus, a small muscle arising from the anterior femoral surface and being inserted into the upper part of the capsular ligament. The synovial membrane is also prolonged backwards, on either side of the crucials, to the posterior portion of the joint and is then extended upwards between the femoral condyles and the heads of the gastrocnemius. In this way it forms two separate pouches connected with the anterior synovial chamber by narrow passages—so narrow as to exclude

the transit of a body much larger than a dried pea (3/16 in. or ½ cm. in diameter.) Fibres of the gastrocnemius are attached to the capsule adherent to these pouches, and thus take up the slack in the capsule and synovial membrane when the joint is flexed (Tenney).

In the infrapatellar region, the synovial membrane sends off a triangular fold which partially crosses the joint and enters the intercondylar notch, at which point it is attached. Prolongations from this fold extend forward and laterally to the capsule. The free edges of these prolongations brush the femoral trochleae as the joint is moved, thus aiding in lubrication. They are called the alar ligaments. The triangular fold of membrane from which they spring is the "ligamentum mucosum." When the joint is extended, the pull upon the capsule is transmitted to the ligamentum mucosum and the alar ligaments, thus preventing the latter from being injured between the articulating surfaces.

Articular Cartilage.—One other feature should be mentioned—the articular cartilage of the femoral trochleae—for it is this area especially which is apt to give off cartilaginous flakes under certain conditions.

Summary.—These structures—the joint capsule with its supporting ligaments and tendons, the semilunar cartilages, the femoral articular cartilage, the crucial ligaments, the tibial spine, and the synovial membrane and infrapatellar fat-pad,—are the structures involved in internal derangements of the knee. Together they make up a joint remarkable for its combination of strength with range of motion, a combination due to the shape of the articulating bones, the interposition of semilunar cartilages, the admirable ligamentous protection both inside and out, and the close apposition of hard and soft structures in all positions of the joint.

ETIOLOGY.

Internal derangements, because of the traumatic element in their etiology, are found much oftener in the male than in the female, a ratio of ten to three in our series. Derangements of the internal semilunar cartilage have been reported more frequently in the British Isles than in this country, and this occurrence may also be explained in part by the traumatic element in sports and coal-mining. It may be, too, that not until recently was the condition so readily recognized in the United States.

At least one condition causing derangements, hypertrophic arthritis, has had a broad field of activity in the human race, both in time

and place, and even visits the lower animals. Bones of the ancient Egyptians have shown its characteristic changes, and the same has been found true of domestic and wild animals of the present day. Its frequency in modern man is graphically shown by outpatient clinics in any large city and by the autopsy findings in subjects past middle life.

It is of some value to know the relative frequency of the different types of cases coming to operation in hospital wards. The figures for the Massachusetts General Hospital between the years 1900 and 1920 are:

Internal Semilunars	43.1%
External Semilunars	8.3%
Loose Bodies	22.7%
Hypertrophic Fringes	13.8%
" Fat-pads	5. %
" Bone	2.8%
Crucial Ligaments	1.7%
Fibrous Bands	1.7%
Chronic Arthritis	1.1%

Trauma, torsion, and toxin are the offending agents. Severe torsion of the knee, in work or play, is the cause of injury to the internal lateral ligament, the internal semilunar cartilage, and the crucials and tibial spine. Less frequently, direct trauma may cause injury to the crucials and tibial spine. Trauma or torsion also produce at least the majority of derangements of the external semilunar cartilage.

Trauma, toxin, and nutritional disturbance are offered by different investigators as the cause of flakings off of the articular cartilage.

The first theory is sponsored by Timbrell Fisher, who supports it by clinical, pathological, and experimental data as follows:

Clinical Data.—Twelve out of thirteen cases in his series had a traumatic history, and in the thirteenth case, microscopic examination of the specimens showed perfectly healthy cartilage and bone cells. Lack of traumatic history may be due to the loose body being of an hypertrophic arthritic origin or to lack of questioning regarding indirect trauma.

Pathological Data.—Examination of the deep surfaces of the specimens showed in many cases the appearance of a fractured surface, and in all cases a freedom from any evidence of granulation of fibrous tissue, or of pitting due to phagocytic action. The specimens composed

only of cartilage showed the cells healthy throughout. In those composed partly of bone, the bone cells were dead, but had evidently died after and not before detachment. (The same behavior of bone cells is observed in experimental grafting.) The site of origin of the body, when it could be determined, was one of the portions of the surface most exposed to injury. The areas around the femoral attachments of the crucials were considered to be subject to injury by severe tension on the crucials.

Experimental Data.—The author has detached portions of the articular surface in the cadaver, by a moderate blow with a hammer upon the lateral margin of the condyle and by putting severe tension on the crucial ligaments. He has also produced a traumatic loose body in a rabbit, the microscopic characteristics of which were almost identical with museum specimens from the human subject.

The second theory—toxins as the cause of flakings off of the articular cartilage—is sponsored by Colvin. This investigator believes that the condition is due to an infectious osteitis. In his cases, he often found no history of trauma. The pain, of an aching character, persisted for some years before there was any real impairment of function. X-rays taken during this time showed localized alteration in the articular surface, from the region of which the foreign body later emerged. He believes that the symptoms are due to a low grade of inflammation and that there is strong presumptive evidence for considering the condition a non-suppurating osteitis.

The third theory—that of nutritional disturbance—has been suggested by Axhausen. He believes that in so-called osteochondritis dissecans, trauma is the important element. But he observes that in the cases in which operation has been performed soon after a trauma, and separated bone found, the microscopic findings suggest a process antedating by a long time the last trauma. In his own case, the process was almost entirely one of resorption, with very active connective tissue and with giant cells eroding the surface of the necrotic bone, findings in marked contrast to those of Fisher, given above. He therefore suggests the hypothesis that the dissecting process may be due to an embolus, perhaps a tuberculous one, and that trauma only completes the separation.

In connection with the last of these theories, we report that certain cases of extreme arteriosclerosis have shown suggestive changes in the surface of bones, notably the sacrum, on x-ray examination. These changes consist of localized areas showing loss of bone substance.

Other types of loose bodies are produced from the synovial fringes and from bony overgrowths in hypertrophic arthritis. In regard to the former, we know that cartilage cells are present in the synovial fringes and that these fringes are derived, embryologically, from the same cartilaginous bar which becomes cleft to form the knee-joint. Another etiological point is that synovial chondromata are often associated with a history of injury and seem to occur frequently in chronic synovitis. They are true neoplasms, however, and the full secret of their etiology is therefore unknown.

In regard to hypertrophic arthritis, the etiology is still obscure. Fisher believes the condition to be the result of prolonged or often-repeated injury, either mechanical or toxic, but of a moderate degree of intensity. He supports the theory of infectious foci as being an etiological factor, in certain cases, and believes that the future will bring to light additional causative agents, such as disorders of the ductless glands. He supports the theory regarding the bacterial toxin group by clinical, pathological, and experimental data.

Ely concludes, from all the evidence at his disposal, that the disease is not of bacterial origin. He states that although all the evidence is against a bacterial etiology, yet the whole appearance of his specimens indicates that an infection of some sort is the cause. He considers a protozoan, most likely the amoeba histolytica, to be the first choice among the possible infecting organisms.

Nichols and Richardson present strong evidence that infectious foci and inflammation play little or no part in the etiology.

Trauma and toxin both enter into the production of hyperplastic changes in the synovial fringes and the infrapatellar fat-pad. If trauma, the initial injury usually comes from without, and may consist of one moderately severe stroke, numerous minor ones, or merely prolonged kneeling as is required in some occupations. The tissue having once been injured and congested, is increasingly subject to trauma thereafter, between the articular surfaces.

If toxin is the causative agent, it produces inflammation and congestion, with the resulting nippings between the joint surfaces described above.

SURGICAL PATHOLOGY.

We have reviewed the normal structure of the knee-joint and shall now view this region after it has been laid waste by the three furies of trauma, torsion and toxin.

Mechanism of Injury of the Internal Lateral Ligament, Internal Semilunar Cartilage, and Crucial Ligaments (Alwyn Smith).—Dislocation or fracture of the internal semilunar cartilage is the most common lesion found in the derangements. It is produced by strong internal rotation of femur on tibia when the knee is in a flexed position. When this rotation takes place, the semilunars first slide internally over the tibial surface, as far as their small range of motion will allow. (All normal rotation of the knee takes place between semilunars and tibia.) If this rotation continues to an abnormal degree the deep fibres of the internal lateral ligament are torn, usually at one extremity and more often at the tibial than the femoral. They may bring a fragment of bone away with them, producing a "sprain fracture."* Further rotation involves a tearing loose of the internal semilunar at its periphery or extremities, or a fracture of the cartilage in a longitudinal or transverse direction.

The next structure after these to receive the strain is the anterior crucial ligament. It may be merely stretched, or may be ruptured. Partial or complete avulsion of the tibial spine, to which the ligament is attached, may take place, either separately or in conjunction with injury to the ligament. As a final step, usually preceding dislocation of the joint, the posterior crucial may be ruptured.

Details of the Pathology of the Internal Semilunar Cartilage and Mechanism of Production.—Reports vary regarding the type of internal semilunar injury seen most frequently at operation, but it seems to lie between a fracture, a longitudinal splitting of the cartilage, and a dislocation, a tearing loose of the anterior end. The other prominent type of fractured cartilage is the transverse, occurring opposite the internal lateral ligament, or in the anterior third.

Besides the dislocation of the anterior extremity, there may be a similar situation at the posterior, or a partial tearing loose of the periphery of the cartilage from the capsule. In the latter case, attempted extension of the knee no longer draws the semilunar sufficiently far towards the periphery, for the connection between capsule and semilunar has been partially severed, and hence locking is apt to occur. This peripher al separation of the cartilage is probably the most frequent of all lesions of the internal semilunar (Barker, Vulpius), but is

*In the case of a sprain fracture, the femoral extremity is involved oftener than the tibial. X-ray shows a small, bony film separated from the femur in the vicinity of the adductor tubercle. If the tibial end is involved, the bony fragment is apt to include part of the articular surface.

not the one most frequently seen at operation, because of the comparative mildness of the symptoms. In other words, a patient sustaining this degree of semilunar injury is not seriously disabled. Locking, if present, is only momentary. The patient does not receive adequate treatment, and healing takes place with the semilunar in this relaxed position and pulled centrally by its extremities. Hence a second injury, similar to the first (i. e., inward torsion with the knee flexed), may cause a severe catching of the cartilage between the joint surfaces, with a consequent fracture or tearing loose of one of the extremities. It is after this or subsequent lockings that operation is performed.

The longitudinal fracture referred to above is probably the result of one of these secondary injuries. The semilunar, because of its relaxed condition, becomes caught between the articulating surfaces. Ensuing torsion pulls on its periphery, while the pressure of the femoral trochlea, especially upon its central fibres, holds it back. The result is a longitudinal split beginning near its anterior extremity, between the peripheral fibres, which are continuous with the transverse ligament, and the central fibres, which are attached separately to the tibia. This anatomical point was first brought out by Billington. If the cartilage is torn longitudinally, the inner portion generally slips centrally, but remains attached at its extremities. It thus roughly resembles an old-fashioned bucket-handle and the type is so designated.

In the case of a free extremity, the locking is most likely due to a slipping centrally or a buckling over of the injured part.

Bizarre forms of the above lesions occur, such as the nodular type of loosened anterior extremity. The cartilage in general may show different degrees of alteration due to long-continued trauma or other causes, and cases have been found in which the cartilage has disappeared entirely (Jones).

Details of the Pathology of the External Semilunar Cartilage and External Lateral Ligament.—Mechanism of Production.—The mode of production of external semilunar injuries is not so clear as in the case of the internal. But in view of the fact that its structure is in general similar to its mate and the pathology found at operation similar to that found in the internal semilunar, it is most likely that the modes of production are similar. In the series analyzed by the writers, reports were obtained in 15 cases. Nine of these had a definite history of injury and six did not. Of the nine, four were due to trauma, four to torsion, and one to acute flexion. (A longitudinal splitting of the cartilage). (A tearing loose of the anterior end).

Descriptions of the operative findings in external semilunar injuries are hard to find in the literature, and on this account the findings in the above series will be described. A summary will first be given followed by some details:

Summary—

2 Fractured
- 1 Transverse
- 1 Longitudinal

13 Not Fractured
- 5 Involvement of Anterior End
- 3 Looseness and Displacement of Whole Cartilage
- 1 " without Displacement
- 1 Detachment of Cartilage with Rolling up of Inner Edge
- 1 Disc-Shaped Outgrowth from Anterior Portion
- 1 Abnormally Thickened
- 1 " Prominent

Only two of the fifteen showed a fracture, one transverse near the anterior attachment and one longitudinal, producing the "bucket-handle" type. Of the thirteen remaining, five showed various involvements of the anterior end, each somewhat different from the other four. One of these had merely a free end, one a thickened end tilted up, one a folded end with a general loosening of the whole cartilage, one had the anterior end dislocated backwards and one showed a projection, perhaps a cyst.

Three showed general looseness and displacement of the whole cartilage, one forward, one backward, and one peripherally. One showed general looseness without any displacement. One showed detachment of the cartilage with a rolling up of its inner edge. One had a disc-shaped projection growing centrally from its anterior portion. Of the two remaining, one was described as thickened and the other as prominent.

One case, not included in our series, showed a presumable cyst arising from the external semilunar cartilage, as described by Phemister and others. The growth constituted an external and not an internal derangement and for this reason was not included in the series. The case will be referred to under "Operative Data" in the report of cases.

An anatomical explanation has been offered for the great preponderance of internal semilunar injuries over those of the external. This is the small range of motion possible in the former, when compared with the latter. The internal cartilage is attached more extensively at the periphery, and its extremities lie further from each other than those

of the external. On this account, there is less "give" when violence is applied to the internal, and its factor of safety is smaller (Jones, Lancet, 1914).

But there is also a physiological feature which helps to explain this situation—the preponderance of torsions inward over torsions outward, on the part of the athlete or worker. The athlete turning suddenly in running and the miner turning to throw a shovelful of coal into a car, both turn towards the opposite side and throw the body weight to the other leg. If the individual turns towards the same side, he must throw his free leg across the other, in order to keep his balance. The latter method of turning must, of course, be used at times, but it is awkward and is not the motion of choice. We know that it is internal torsion rather than external which produces internal semilunar injuries. Assuming that a corresponding torsion, i. e., external, produces external semilunar injuries, we thus have an additional explanation for the comparatively small number of these lesions. In the cases in which direct trauma is given as the cause, it may be said that the inner portion is more exposed to direct injury than the outer, both because of the natural manner of maintaining balance described above, and because of the prominence of the inner portion of the knee.

In regard to the external lateral ligament, its pathology is similar to that of the internal, the tibial extremity being the part most frequently injured.

Details of the Pathology of the Crucial Ligaments and Tibial Spine.—Mechanism of Production.—In regard to rupture of the anterior crucial ligament or avulsion of the tibial spine, it seems to be a matter of relative strength which of these two lesions will occur. Both may occur together. A rupture of the anterior crucial seems to involve the femoral attachment more frequently than any other part. The usual picture presented by such a rupture shows only a small fragment of the ligament remaining, the rest having disappeared.

Because of the intimate association of the extremities of the external semilunar with the spine of the tibia, these extremities may become involved in injuries to the tibial spine or anterior crucial. The internal semilunar cartilage is, of course, involved in nearly all cases of anterior crucial injury, because they are both produced by the same type of violence, i. e., torsion inwards or medially, and the former is injured before the latter. Rarely, an anterior crucial injury is produced by forcible hyperextension of the knee.

The fractures of the tibial spine occurring in conjunction with anterior crucial injury are either a fracture of the whole spine or of its internal tubercle. The latter receives the insertion of the anterior crucial ligament and is for this reason the only part of the spine avulsed in certain cases.

Fracture of the external tubercle of the spine also occurs, but this is not associated with crucial ligament injury. It is produced by a rotation inward of femur on tibia, followed by a forward thrust of the femur, whose external condyle sweeps off the bony prominence. The fracture of the external tubercle is therefore preceded by a rupture of the internal lateral ligament and at times by a derangement of the internal semilunar cartilage as well.

Fracture of the external tubercle is in rare cases associated with fracture of the internal tibial tuberosity and vice versa, fracture of the internal tubercle with fracture of the external tibial tuberosity.

Loose Bodies in the Knee.—Timbrell Fisher, whose research on this subject has been referred to before, concludes that loose bodies are produced in three different ways: (1) by a more or less generalized pathological process, such as hypertrophic arthritis, tuberculosis, tabes, or arthritis due to infection; (2) by localized violence to an otherwise normal joint surface; and (3) by the formation of chondromata from the synovial villi. He describes these groups as follows:

(1) Bodies produced by hypertrophic arthritis are of two varieties: synovial chondromata (identical macro- and microscopically with those which he describes under that heading), and osteo-cartilaginous bodies. The latter come from various points of the articular surface, as fractured hypertrophic nodules, but especially from the periphery. The femoral and patellar surfaces are by far the most apt to produce these bodies. They show on section a bony center surrounded by a cartilaginous zone. On microscopic examination, the bone is seen to be dead. There is a zone of living cartilage cells around it, and outside of this a peripheral zone of fibrous tissue. Grossly, the body may show a narrowing at one extremity, indicating its previous point of attachment. It is unusual for more than two or three of these bodies to be found in the joint, but they may co-exist with synovial chondromata of varying numbers. By these macro- and microscopic features, the source of the body can be determined.

Bodies produced by tuberculosis come more frequently from the femoral surface than from the patellar or tibial. They are probably produced by interference with the blood supply of the affected portion,

and this may account for their wedge-shaped form. It is interesting to compare this theory with that of Axhausen, given above, as to the possible etiological factors in so-called osteochondritis dissecans.

(2) This is the group of bodies found in joints whose appearance is otherwise normal. They occur more frequently in males than in females and come especially between the ages of fifteen and twenty-five years. Their source is the articular surface of femur, patella, or semilunar cartilage. It is rare for them to come from the tibial surface.

Bodies Derived from the Articular Surface of Femur or Patella.—The particular localities most apt to produce them are those portions exposed to injury by severe traction on the ligaments or by direct trauma. The portions most frequently involved, therefore, are the areas adjacent to the femoral attachments of the crucial and posterior capsular ligaments, and the exposed portions of the femoral trochleae. They occur in different varieties.

The commonest is a circular or oval, almond-sized, osteo-cartilaginous body, with a plane surface on one side and a convex on the other. When this fragment lay in its normal place, the plane surface lay deep, in apposition with the tissue from which it was broken off, and this surface accordingly shows different degrees of roughness, altered by the degree of proliferation that has taken place since its fracture. (In contrast to this finding, Axhausen reports a specimen which showed active connective tissue and giant cells eroding the surface. Colvin reports the cavity from which a fragment had escaped as presenting a raw, bleeding surface appearing like granulation tissue, and the surrounding bone as being indurated. He considered these appearances suggestive of chronic bone infection.) The convex surface has the typical appearance of articular cartilage. The edge is smooth and rounded, due to the growth of cartilage over it. Cross section shows a thick zone of cartilage on the convex side and bone on the plane. The cartilage has grown to a certain extent over the edge and upon the plane, bony surface. Microscopic examination shows the cartilage cells to be alive, but nearly all, or all, of the bone cells to be dead.

Other varieties of this group are similar to the above, except that they show different degrees of cartilaginous proliferation, from the fragment so recently separated that it shows no proliferation, to the veteran, thickly studded with hyperplastic nodules. There is one more variety of the femoral or patellar articular surface type and this is put in a class by itself, because it is the only one showing the formation of new bone. Bodies of this variety all show incomplete detachment

from the parent tissue, or secondary attachment to fresh tissue. The explanation is that the osseous tissue gets its nourishment through these attachments, while cartilage does not require attachment to any structure for its survival.

Bodies Derived from the Semilunar Cartilages.—These bodies most frequently come from the anterior extremity of the internal cartilage. Occasionally, the posterior extremity of the internal or one of the horns of the external cartilage gives off the body. It may be either attached by a pedicle or lie free in the joint.

Bodies derived from the articular surface of bone or cartilage usually occur singly, but two or three may be present. They are occasionally bilateral. Regarding their location in the joint, bodies originating in the anterior chamber are pretty sure to stay there, because of the small calibre of the passages leading to the posterior chambers. A body may lodge behind the anterior crucial ligament and escape detection, unless special search is made for it. The knowledge of this point may prevent the dilemma of the hunter for eggs on Easter morning.

(3) This group comprises chondromata derived from the synovial villi. They may be either single or multiple, and pedunculated or free. One type shows numerous small bodies scattered through the synovial fringes, resembling a type of sea-weed familiar to the Atlantic coast.

The single bodies are larger than the multiple, and tend to occupy recesses in the synovial chamber. On account of both of these features, they rarely slip in between the articulating surfaces, and are often discovered accidentally post-mortem. The diameters of two such reported specimens were one and two-fifths inches (3½ cm.) and three-quarters of an inch (2 cm.) respectively.

Multiple chondromata may occur in great numbers, one case having yielded over one thousand at operation.

Hypertrophic Synovial Fringes and Infrapatellar Fat-pad.—The term "hypertrophic," applied to these soft tissues and used frequently throughout the paper, does not imply any bony change. Hypertrophied fringes and fat-pad are closely associated. Their mode of production is the same, i. e., trauma with or without toxin, and their pathology similar. They often occur together.

In regard to the fat-pad, the primary pathological picture is usually a bruising and congestion, often with extravasation of blood, from external trauma. This congested, enlarged condition of portions of the

pad causes the free edges readily to slip in between the articulating surfaces and sustain injury. The more trauma they receive, the larger they grow, and thus enter into a vicious circle. The pathological picture, therefore, varies according to the duration of the trouble. The earliest cases show a normal color or a reddish-yellow tinge. Blood clots may even be found. The later cases show different degrees of granulation and fibrosis. Cross section of the specimen may show varying degrees of fibrosis, and also hemorrhagic points and distended vessels. Microscopic examination shows reduction in the amount of fat, sometimes with necrosis, and its place taken by a fibrous tissue (Hoffa). The endothelial cells of the synovial membrane may therefore lie in apposition with the fibrous stroma of the pad, and without any intervening fat.

A tear in the synovial covering of the pad may result in a herniation of fat into the joint and, because of repeated trauma, an exuberant growth of various portions of the mass which finally produces an arborescent appearance. Such an "arborescent lipoma" is commonly located in the upper, outer portion of the anterior compartment. It may grow large enough to fill the joint and distend the capsule.

Certain individuals, especially those who show an unusual amount of fat elsewhere in the body, have unduly large infrapatellar fat-pads. These pads, because of their size, may receive a primary injury between the articulating surfaces, without having sustained any external injury.

The fringes involved are usually outgrowths from the alar ligaments. Their hypertrophy is due to an initial injury or to toxic action with subsequent traumata from the articulating surfaces, just as in the case of the fat-pad. The result is a congestion and elongation of the fringes, with a variable amount of inflammatory and fibrous change.

Hypertrophic Bone.—Timbrell Fisher's article was the source of the following data, and should be consulted if more details are required.

These bony changes are produced by hypertrophic arthritis and may show themselves as lippings or nodular outgrowths of the articular cartilage, especially of the femur or patella. A nodule may break off, forming a loose body in the joint. This condition has been described in the discussion of loose bodies.

The most striking feature of the early changes in an hypertrophic joint is the apparent fibrillation of the central portion of the articular cartilage. This change, on closer examination, is seen to be merely a splitting of the matrix, without fibrous metaplasia and is believed (by Fisher), to be due to the percolating of toxins through the meshwork of the superficial structure. This is the same path followed by the synovial

fluid in reaching these tissues. After this change appear lippings at the periphery, due to chondrous proliferation. These reactions are, of course, in marked contrast to each other, and are explained by Fisher on structural and nutritional grounds: structurally, the peripheral portion of the cartilage is furnished with a perichondrium, while the central portion is not. Physiologically, the periphery receives blood from the vascular circle of the joint, graphically shown in one of his illustrations, while the superficial layer of the central portion has only the synovial fluid to draw upon.

The peripheral outgrowths gradually increase in size and are invaded by osseous tissue from beneath. Similar outgrowths develop in the more central portions of the articular cartilage, the first stage of their formation being localized hyperplasia in the deeper portions of the cartilage, in which nutrition is obtained from vessels in the cancellous bone beneath. These hyperplastic areas are invaded by osseous tissue and then in some way become separated from the surrounding cartilage. One explanation offered as the mode of separation, is a fibrous metaplasia at the line of demarcation. These bodies finally appear as nodular outgrowths in the articular surface. Both peripheral and central outgrowths may become large enough to interfere with function, but they are much less likely to do so if the joint is put through its full range of motion daily.

The degenerating cartilage in the central area finally disappears and exposes a hard, eburnated bony surface. The sclerosing process in the bone begins before the cartilage is entirely worn off and is probably in the nature of a protective reaction.

Synovial changes begin when the peripheral lipping first appears. A thickening of the soft tissues adjacent to these lippings takes place, and a general increase in the size and number of the synovial villi. (This villous hypertrophy, however, is not nearly so prominent a feature in hypertrophic arthritis as it is in the atrophic and infectious arthritis of Goldthwait or the proliferative arthritis of Nichols and Richardson.)

Opinions differ regarding the question of increased vascularity. Fisher states that the involved portions appear unduly vascular, while Swaim states that there is no increase in the vascularity. The synovial villi at this stage may give rise to chondromata, as described previously. In a later stage, the villi undergo secondary changes and the membrane becomes smooth and atrophic.

Summary.—The pathological picture is therefore one of violence, slow change, or both combined:—violence in the case of injured internal lateral

ligament, semilunar cartilages, tibial spine, crucial ligaments, and loose bodies derived from the articular surfaces; slow change in the case of synovial loose bodies and hypertrophic bone; both combined in the case of hypertrophic soft tissues.

SIGNS, SYMPTOMS, AND DIFFERENTIAL DIAGNOSIS.

We believe that by far the best way to present signs and symptoms is by means of actual case histories. By this means we hope to present the different aspects of the problem more graphically, perhaps relieving tedium at the same time by means of the personal element. We shall, therefore, cite cases of each of the different types of derangement, and beneath them discuss other features not illustrated by these cases. We realize that the case histories are not so complete as one could wish, but the discussions cover those points omitted by the busy interne. We shall conclude each case with the differential diagnosis.

Internal Semilunar Cartilage.—A boiler-maker, 31 years old, was admitted in June, 1917, complaining of recurrent locking, pain on standing up and starting to walk, and inability to fully extend his knee.

Ten months previously, he had wrenched his knee while running on the beach and was unable to use it for three weeks. During that time he had swelling, stiffness, and limitation of flexion, but not very much pain. He had no more trouble for four months, when he slipped on the ice and suddenly hyperextended his knee, causing a recurrence of the pain. He obtained some relief by the application of a liniment. Four months later, he wrenched the knee again and was referred to the outpatient department.

The record further states that since the onset of the trouble he had had several attacks of locking, always with swelling and pain for several days afterwards. The limitation of flexion following the first injury was presumably one of these occasions.

Local examination showed a normal-appearing knee, with no evidence of fluid. A small, tender area was found in the joint line just anterior to the internal ligament. Flexion was normal but extension was limited five degrees.

X-ray in the antero-posterior plane showed a small, dense, calcified mass just below the patella and an irregularity in outline of the upper surface of the tibia. There were hypertrophic changes in the joint as well. Diagnosis.—Probable fragment of displaced semilunar cartilage.

Discussion.—It would have been of value to know more about the nature of the lockings, whether they came as a result of mild torsion, were accompanied by a sickening pain and persisted for a time with perhaps some difficulty in reduction, or whether they came without warning, were only moderately painful, and were of a transitory nature. The former would have suggested a semilunar; the latter, a loose body.

There was probably no palpable mass present at the times of locking, or there would have been a statement to that effect. We assume also that on examination no hypermobility was found, either laterally or in the antero-posterior direction. This question of hypermobility is a very important point, for by this means an injured lateral or crucial ligament may be diagnosed, and more inclusive treatment employed. Details of hypermobility in crucial injuries will be given under that heading.

The x-ray findings rarely give us positive information in a case of deranged semilunar, by revealing a mass in the semilunar area. The usual findings are negative as far as the semilunar is concerned, and the purpose of the x-ray is to rule out loose bodies. Oxygen or nitrogen inflation of the joint, with subsequent x-ray, has been found to furnish positive evidence in cases of torn semilunar. The gas works around behind the torn portion, thus throwing it into sharp relief against a black background. (Bircher believes this procedure will become as indispensable for knees as cystoscopy is for the bladder. Out of nine cases of lacerated semilunar which he thus examined, the diagnosis was confirmed by operation in eight. The ninth was presumably not operated upon. In another of his cases, a suspicion of tuberculosis was disproved.)

The patient in question was evidently suffering from a recurrent cartilaginous or bony derangement, brought on by wrenching the knee ten months previously. A derangement due to soft tissues would not often have so marked a traumatic onset nor cause such marked symptoms. The probabilities were therefore a semilunar cartilage or a loose body.

In the first place, no loose body had been observed at any time, and in the second, the mode of onset was not typical of a loose body, but was typical of a deranged semilunar. The former usually produces no locking for an interval after the injury, while the latter is apt to produce symptoms immediately. Then the severity and duration of the symptoms following succeeding lockings in this case pointed towards semilunar rather than loose body. A minor point is that the frequency of the former derangement is greater than that of the latter—two and a half times as great, in our series.

Local examination showed tenderness adjacent to one of the two areas

typical of an internal semilunar injury—i. e., the joint line, over the internal lateral ligament and over the anterior horn of the semilunar (Jones). Areas of tenderness in the case of a loose body are not so common nor so constantly situated.

The possibility of the external semilunar being involved instead of the internal was not likely enough even to be considered, in view of the location of the tender area and the general preponderance of internal involvements over the external. Sir Robert Jones places this proportion at nine to one; Martin, at 11½ to 1. Strahlman and White found a proportion of five to one, and our series agrees with the latter. Sir Robert's figures, however, are based on many times the sum total of the last two series.

Operation revealed a loosened and partially free anterior end of the internal semilunar. The cartilage was excised and the patient relieved entirely thereby. He resumed his trade as a boiler-maker.

External Semilunar Cartilage.—A clerk, 30 years old, was admitted in August, 1913, complaining of recurrent attacks of pain on the outer aspect of the left knee, and inability fully to extend the joint.

His trouble dated from seven months previously, when he slipped and twisted his knee, thereby causing much pain and a feeling as if something in the joint were interfering with its full extension. He remained in bed for three days and limped for three weeks thereafter. At the end of that time he voluntarily twisted his knee and felt something slip, thus ridding himself of the limitation and pain.

He had had a recurrence of the trouble four months before entry and had not been able to fully extend his knee from that time on. The pain was always localized on the outer aspect of the knee.

Local examination showed a normal appearance. On palpation, however, a very tender area was found just below the outer edge of the patella.

Discussion.—The story and examination are rather similar to the case with internal semilunar derangement, except that the symptoms are not so severe, and the localization of the pain and tenderness is on the outer instead of the inner aspect of the knee. Eleven of our fifteen cases of external semilunar derangement had pain, tenderness, or discomfort localized on the outer side of the knee, usually at the joint line. One of these had as much tenderness internally as externally. Of the four remaining, two had no pain or tenderness and in two there was no definite statement one way or the other, thus implying no pain nor

tenderness.* Nine had a story of previous injury; six had none.

The only other condition to be considered in this case is the presence of a loose body, and the points pro and con have been discussed in connection with the internal semilunar case.

Operation revealed the "bucket-handle" type of external semilunar derangement, with adhesions. The cartilage was removed, with entire relief to the patient in between six and twelve months. The length of convalescence time was perhaps due to the presence of adhesions. The patient is on his feet about seven hours a day.

We assume that the persistent limitation of extension for four months previous to operation was a permanent locking.

Crucial Ligaments.—A married woman of 36 was brought into the Accident Room by the police, who said that she had been knocked down by an automobile shortly before.

Examination showed her to be in a marked state of excitement, crying out and thrashing wildly about. Both her head and right knee had been injured. The latter showed some ecchymosis, swelling, and marked hypermobility, both antero-posteriorly and on abduction. A chip had also been broken from the inner border of the head of the tibia, as revealed by x-ray.

Discussion.—A history of injuries in these cases helps to exclude cases of relaxed ligaments due to a Charcot joint or to locomotor ataxia (Jones and Lovett). The outstanding feature from the diagnostic point of view is the hypermobility of the joint. The marked antero-posterior mobility shows that one or both of the crucials has been partially or completely ruptured. It is presumably the anterior which is involved, as this is the much more frequently injured one of the two. If the statement had been definitely made whether the tibia could be displaced anteriorly or posteriorly, we could say definitely—the anterior in the former case, the posterior in the latter. (Hypermobility due to anterior crucial injury is more evident with the knee in full extension; that due to posterior crucial injury is more evident with the knee in full flexion.) Two other forms of hypermobility should be mentioned: Internal rotation of tibia on femur, with the knee in full extension, is considered by Sir Robert Jones to be diagnostic of crucial injury and is especially valuable if there is doubt about antero-posterior mobility. The second

*Sir Robert Jones states that symptoms on the outer side of the knee may be produced by deranged internal semilunar and Barker has described internal symptoms being produced by an external cartilage. The logical procedure seems to be to operate on the painful or tender side, other features being equal.

form is lateral "rocking," which is considered by Alwyn Smith to be the main symptom of stretched anterior crucial.

Marked abduction means that the internal lateral ligament must have been injured along with the anterior crucial. X-ray shows us a detail of the nature of this injury, a chip from the tibia at the insertion of the fibres of the lateral ligament. Pressure over the tibial end of the ligament would probably have revealed an especially tender point. The condition is a sprain fracture involving the internal lateral ligament.

The question of fractured tibial spine always comes up in a crucial injury, because such a fracture may obstruct and prevent a good result. The question is answered by attempted extension of the knee and by x-ray. A bony block is the most constant sign of a fractured tibial spine. If extension is complete, there is at least no obstruction, and the question of a fracture without obstruction is answered by x-ray. (There was no fracture of the spine in this case.)

In such an injury as this case shows, there may well be a deranged internal semilunar with locking. The question may then arise whether limitation of motion is due to this condition or to a fractured tibial spine. In the former case, motion is not stopped so abruptly and the obstruction seems to be of a less resistant nature than in the case of a bony obstruction. X-ray is the final court of appeal. Fracture of one of the tibial condyles is occasionally found in a severe injury of the type cited above.

Operation was performed between five and six weeks after entry and revealed injury of both crucials—a complete rupture of the anterior at its femoral attachment and a partial tear of the posterior. The anterior crucial was restored by means of a suture passed through the external condyle to the site of its femoral attachment, then drawn down to the ruptured end and sutured to it. The free end was passed back through the external femoral condyle. The result was poor, not because of hypermobility, but because of marked limitation. This limitation was presumably due to the severity of the injury.

Loose Body.—A barber, 48 years old, was admitted in April, 1909, on account of recurrent pain in his left knee and occasional locking.

He had injured the knee six or seven years previously while wrestling, and on occasions since that time had felt a small lump, usually on the inner side of the knee but at times on the outer. By manipulating the lump, after locking had taken place, he could regain motion. He had had considerable pain at times, especially at night.

Examination showed a normal-appearing knee, with a marked, soft

crepitus on motion. No mass could be found. X-ray showed, "At least two loose cartilages in the joint cavity."

Discussion.—Assuming that the patient is a normal individual, a diagnosis of loose body is made on his story alone. The soft crepitus on examination is consistent with the diagnosis, as being probably due to chronically traumatized tissues. X-ray confirms the diagnosis and further indicates that two loose bodies are present instead of one. It does not assure us of the fact, unless we can see the plates for ourselves and make sure that a sesamoid bone has not been mistaken for a loose body. The points indicating a sesamoid are an apparently extra-articular location and a flatness of the deep surface (Henderson). Differential points between loose body and deranged semilunar are given under the latter heading but are not needed in this case.

Regarding the probable source of the loose body, we rule out hypertrophic arthritis because of the negative findings on examination and x-ray. Then too, the patient was only 42 years old at the time of onset of his derangement, a little young to have hypertrophic arthritis. We consider the synovial membrane as a less likely source than the articular surface, because of the definite history of injury and also because of there being only two bodies present at the most. The synovial membrane, while often producing only a single body, also gives rise to various numbers, but the traumatized articular surface rarely gives rise to more than two or three. Multiple chondromata, because of their smaller size, produce more frequent locking than does the body from the articular surface, but the locking is not so severe.

Only one body was found at operation and this was not described sufficiently to identify it as belonging to any one of the three classes. The patient has had no trouble since.

Timbrell Fisher, with a clairvoyant eye, describes the actions of a loose body side by side with the symptoms produced:

A portion of articular surface is completely detached by trauma, wanders freely in the joint for a time and then becomes secondarily attached to the synovial membrane. The symptoms are therefore sudden attacks of sharp pain, often followed by swelling or momentary locking. The first of these attacks comes on almost immediately after the injury, and after a time they disappear.

In another type of case, the articular fragment is completely detached by the injury as in the first case, but almost immediately becomes secondarily attached, and after an interval becomes free again. The patient therefore has a free interval after injury, and then the characteristic attacks.

In still a third type, the articular fragment is gradually detached and at length becomes free. In this case, the process of detachment is accompanied by attacks of pain and swelling, often increasing in severity, and finally the more severe attack.

Hypertrophic Fringes.—A female shoe-worker of 43 was admitted in August, 1904, on account of persistent trouble with her right knee.

Six years previously, she had developed severe, jumping pain in both shoulders and then in all her joints, except ankles and back. There was some sweating during this attack but other symptoms were not recorded. Her right knee had continued to trouble her ever since, by tiring easily, giving considerable discomfort on walking and a feeling of something slipping in the joint, but not locking it.

Examination.—In her left hand, there was thickening of the fourth carpo-metacarpal joint and of both interphalangeal joints in the same finger. Her left knee gave a dry crepitus on motion. Her right knee was considerably enlarged by a thickened capsule. On motion, there was considerable crepitus and "fringes could be easily palpated." "A fringe or loose cartilage on the external aspect could be pushed into the joint, almost locking it completely." Flexion was possible to a right angle and extension was limited fifteen degrees. No x-ray was taken.

Discussion.—To begin with, we should state that this case differs from the average in that the onset was toxic instead of traumatic, the duration of the trouble before operation longer than is usual, and the joint pathology found at operation a good deal more extensive. The average findings are given under this heading in the section on surgical pathology.

The patient had developed a multiple arthritis of the "proliferative" or "infectious" type, six years previous to her entry and had sustained persistent disability to the internal structure of her right knee. She probably developed the trouble with the joints of her hand at the same time.

The discomfort in walking and the tiring easily point to a chronic inflammatory process of the soft or hard tissues, but the feeling of something slipping indicates an additional trouble—mechanical interference with joint motion. This symptom is of a mild nature and has never been accompanied by locking, thereby indicating a soft tissue rather than a hard tissue derangement. The mode of onset—a toxic arthritis—indicates pathology of the synovial villi rather than of the

infrapatellar fat-pad. (An acute toxic process is more apt to cause hypertrophy of the synovial villi than of the infrapatellar pad.)

A local examination is required, however, to decide whether fringes, fat, or both are involved. It shows a general thickening of the capsule, a condition seen in hypertrophic villi and not in an hypertrophic fat-pad. In addition, the "fringes could be palpated," a finding which was probably correct, in view of the operative findings. The motion was markedly limited, so much so that it should be attributed to a more extensive process than a mere hypertrophy of soft tissues. However, fringes usually give some limitation while a fat-pad gives very little. There was also considerable crepitus, which is more than we should expect from a fat-pad. Finally, inspection failed to reveal a feature seen at times in fat hypertrophy, a swelling on one or both sides of the patellar tendon.

We therefore place villous arthritis ahead of hypertrophic fat and come to the last question, the nature of the "fringe or loose cartilage" on the external aspect of the joint. The history and examination, except for this, point to a soft tissue rather than a cartilaginous derangement. Besides, it would be an unusual way for an external semilunar or a loose body to behave; the former is seldom palpable and the latter not so persistently palpable as this structure was. We therefore conclude that it is an hypertrophy of synovial tissue.

Operative findings showed a degenerated synovial membrane forming long, congested, thickened tongues, and exposing bare bone in many places. Many fringes and bits of loose tissue were removed.

The patient reported one year later that she doubted whether operation had helped her at all, and seven years later that the operation had been a great benefit.

Hypertrophic Arthritis.—A well-built colored man of 57 years, but not looking so old, a postal clerk by occupation, was admitted from the outpatient department in March, 1908, suffering from chronic pain on the inner aspect of the right knee.

Nine months previously, he had struck this portion of his knee against a mail truck and had suffered considerable pain at the time, but had had no swelling nor heat. He was treated in the outpatient department by adhesive strapping and plaster casts, but obtained only temporary relief therefrom. At the time of entry he was unable to stand at his work without suffering much pain, and had still more trouble on walking.

Examination.—His teeth were fair, his tongue fringed with several small, herpetic areas, his throat injected, and his tonsils not described. The abdomen was somewhat pendulous.

The right knee was normal in appearance, except for a slight prominence on the upper, inner border of the tibia. There was some tenderness in this area, but no heat. The motion of the joint was limited and painful on extreme flexion.

X-ray showed osseous projections from both the inner and anterior borders of the upper end of the tibia.

Discussion.—This case differs from the average hypertrophic arthritis in that it had a traumatic onset. In most of them, the cause of onset is unknown. This particular patient probably had an hypertrophic overgrowth at the time of injury, and suffered especially on this account.

The trouble was all localized at the inner aspect of the knee, where a bony prominence was found both on examination and by x-ray. The condition of the other joints was not stated. The pain was of a chronic nature, was made worse by prolonged use of the knee, and was never accompanied by locking. The story so far suggests chronic inflammation of tissues on the inner aspect of the knee, with no more disability than would be produced by pressing upon them in using the joint.

We look for a source of this inflammation and find it in the injury at onset, but cannot yet explain its persistence. On examination, we find a bony overgrowth over the upper, inner border of the tibia, with tenderness, and see by x-ray that this overgrowth is more extensive than is revealed by palpation. We feel a "creaking" sensation on moving the joint, indicating chronic involvement of the soft tissues.

Our findings so far are a tender, hypertrophic bony overgrowth on the inner aspect of the knee; hypertrophic bone elsewhere which cannot be palpated; and probably chronic irritation of the synovial membrane. We find no evidence of any tissue having been shifted from its normal place, for there has been no history of locking, nor of sudden attacks of pain with or without effusion, nor any fullness in the joint line. We therefore localize the trouble on the inner aspect of the joint and explain it by the bony overgrowth there, with the attendant changes in the soft tissues which we know must exist. The articular cartilage itself is insensitive, but the adjacent soft tissues are subject to pain.

Operation revealed a rough ledge of bone projecting from the antero-internal portion of the inner femoral condyle, and a bony spur on the tibia in a corresponding position.

As proof that these bony overgrowths were the source of symptoms,

it should be stated that the corresponding ledges on femur and tibia were removed, with resulting improvement for twelve years.

Summary of Signs and Symptoms—The main features of the different types of cases will now be summarized, but there are many exceptions to the following statements, which in a summary are necessarily omitted. The most satisfactory method, probably, is to make a bald statement of the features as they appear in the average case and to leave the exceptions to be implied from the previous discussions.

Lateral Ligaments.—No case history of this type was cited, as the condition is not an internal derangement. It predisposes to semilunar injury, however, and is often associated with semilunar or crucial derangements. It must therefore receive a proper place in any general discussion of internal derangements.

The internal lateral ligament is much more frequently involved than the external. The mode of onset, signs and symptoms of the former condition are similar to those of a semilunar derangement occurring for the first time, except that the symptoms are not so severe, locking is absent, and tenderness is usually localized at the lower extremity of the ligament instead of over the anterior horn (Jones and Lovett). So the history begins with a severe, inward torsion of the knee, with sudden pain on the inside and often a sensation of something snapping. There is no locking, however, and the patient is able to walk, but with some difficulty. The pain is severe and persistent, and is usually followed by effusion.

Examination shows marked tenderness, usually at the tibial attachment of the ligament, increase in tenderness on attempted abduction of the knee, and often slight mobility in this direction. X-ray may show that a flake of bone has been torn away, thereby producing a sprain fracture. Instead of the tibial extremity, the femoral may be the portion affected.

The signs and symptoms of an external lateral ligament injury are similar to those of its mate, except that they are localized externally instead of internally.

Internal Semilunar Cartilage.—These cases have an average age of about 31 years, usually have a traumatic onset, always have pain and usually have locking with effusion. Their pain is confined to the inner portion of the knee and their lockings are rather serious occurrences, often with some difficulty in reduction. They have no limitation of

motion, unless the locking is continuous. Examination may or may not show effusion, but palpation of a case with recent locking often reveals two tender areas,—one in the joint line over the internal lateral ligament and the second over the anterior horn of the cartilage. X-ray examination is generally negative.

External Semilunar Cartilage.—These cases differ from the preceding type, in that they do not so often have a traumatic history, their symptoms in general are probably not so severe, and their pain and tenderness are on the outer aspect of the knee.

Crucial Ligaments.—The anterior is by far the more frequently involved. The patient has a history of severe trauma to the knee, and on examination of a recent injury shows swelling and ecchymosis. If the ligament is torn across, there is definite hypermobility in the antero-posterior direction, and the nature of this hypermobility shows which of the two ligaments is involved. Two other types of mobility of diagnostic value are internal rotation of tibia on femur, with the knee fully extended, and lateral rocking. Hyperabduction is usually present as well, from an injured internal lateral ligament. X-ray may or may not show a fracture of the tibial spine.

Tibial Spine.—There is a history of severe trauma, similar to that of a crucial case, and the crucial is often injured at the same time. Examination may reveal limited extension, and in this case the obstruction seems to be of a hard, bony nature. The internal semilunar may have been injured and may be the obstructing tissue instead, in which case the obstruction is of a less resistant nature. There may or may not be antero-posterior hypermobility, according to the condition of the crucial ligaments and their bony attachments. X-ray gives positive evidence.

Loose Bodies.—The average age is 38 years. The patient has often diagnosed the condition himself. He gives a traumatic history less often than do the internal semilunar cases but just about as frequently as do the external semilunar. There is usually a free interval between injury and onset of locking. The lockings are transitory and the pain accompanying them less severe than in semilunar derangements. The pain is often referred to different parts of the joint. X-ray usually gives positive evidence.

Hypertrophic Fringes.—These patients have an average age of about

33 years, give a traumatic history in about half the cases, and a history of arthritis due to infection, in a smaller percentage. They have had recurrent, sudden attacks of pain, but not of a severe nature, accompanied by effusion. They have not had severe attacks of locking, but may have had feelings of interference with joint motion, and in old cases, real locking.

Examination shows the knee slightly "full", and often with localized swelling on both sides of the patellar tendon. Palpation shows the joint capsule to be thickened and the localized swellings to be of a variable degree of resistance. There is slight tenderness on deep pressure, both over joint line and swellings. Motion of the joint produces crepitation and is a little limited. The quadriceps extensor shows some atrophy of disuse.

Hypertrophic Fat-pad.—The average age is 34 or 35 years. Over half the cases give a history of trauma or prolonged pressure. They have had transitory attacks of pain with effusion, like those of the villous cases. A dull ache is often present behind the patella (Jones and Lovett.) Examination often shows the swellings about the patellar tendon referred to above, and these swellings are slightly tender on deep pressure. They vary in degree of induration, on account of fibrotic changes. The knee does not look "full," except in certain cases of lipoma arborescens, and the capsule does not feel thickened. Joint motion reveals fine crepitation and is very slightly limited, if at all. Atrophy of the quadriceps is seen, as in the villous cases.

Hypertrophic Bone.—The average patient is over 50 years old, has no traumatic history and has had chronic pain, especially on use, for some time. He has also been troubled with limitation of motion and may or may not have had swelling. General examination often shows hypertrophic changes in the distal interphalangeal joints of the fingers or in other joints. Local examination shows bony overgrowth at the joint line, and there is apt to be tenderness in one or more of these areas. X-ray reveals more bony overgrowth than is evident on palpation.

Foreign Bodies (Jones).—This and the following three conditions will be taken up for the sake of differential diagnosis, as they may be confused with internal derangements. The foreign body most frequently found in the knee, in civilian life, is a neeble, accidentally introduced in children or purposely in neurotic adults. It is apt to be a confusing case because of the bizarre nature of the symptoms. It may give remittent

effusion and locking, with very little local tenderness. The nature of the case is revealed by x-ray.

"Clicking" or "Trigger" Knee, (Jones and Lovett).—This is the condition in which a loud click is heard on acute flexion and sometimes on complete extension. If in extension, it occurs when the motion is all but complete and is accompanied by external rotation of the tibia. The causative findings so far have been obstructions associated with the anterior horn of the internal semilunar, and osteomata.

Osteomata (Alwyn Smith).—These growths often give rise to no symptoms at all. Those interfering with the inner or outer hamstrings are the ones which concern us most and are usually found just above the femoral condyles. The symptom most frequently complained of is a "slipping" at the back of the knee. Sometimes there is a complete locking, due to interference with the hamstrings. There is never any synovitis. The symptoms nearly always occur during active exercise. X-ray settles the diagnosis.

Simulation of Knee Derangement in Hysteria (Barker).—When such a knee is examined and motion attempted, the opposing muscles are felt to become tense and to resist. Etherization clinches the diagnosis. Barker tells of an interesting case in which he wanted to prove to the patient that she had no organic trouble with her knee. Without telling her what he proposed to do, he injected a spinal anaesthetic and then draped a sheet so that she could not see her knee. After the anaesthetic had taken effect, he began moving the knee and then had the sheet suddenly removed!

TREATMENT

The treatment of internal derangements aims at the correction of the deranged and injured condition of the tissues, accompanied by rest, so that the tissues may help to heal themselves. This correction is brought about by non-operative, operative, and medical means.

Lateral Ligaments.—The rupture of fibres of the internal lateral ligament is apt to cause a persistent laxity and sometimes to imperil the semilunar cartilage, unless the rupture is given ample opportunity to heal. The knee is therefore immobilized in a posterior wire splint or a plaster cast from hip to ankle, according to the severity of the rupture. Weight-bearing is allowed in from seven to ten days in the average case.

Immobilization for a period of four to six weeks is usually long enough. In addition, strain should be taken off the ligament by throwing the foot into varus, both by raising the inner portion of the sole and heel ¼ to ⅜ of an inch, and by instructing the patient to walk with his feet turned straight ahead and his weight thrown on the outside. A ruptured external lateral ligament calls for the same treatment, except that the foot must be thrown into valgus and the patient instructed to throw his weight on the inner side of his foot.

A chronically stretched lateral ligament is treated by the varus position of the foot and a cage splint to prevent lateral motion, or by operation. One of these operations, devised by A. H. Edwards, reinforces the internal lateral ligament by means of tendon transplantation of the semitendinosus and gracilis. A second, devised by McMurray, shifts the lower portion of the sartorius forward to the bed of the lateral ligament, but without touching the insertion of the muscle. A third, devised by John Wilson, utilizes a band of fascia lata, which is cut from the internal aspect of the thigh, turned down upon the injured ligament, and sutured in place. In cutting the fascial band, the lower extremity is not divided. Edwards has also worked out an operation for the relaxed external ligament, by transplanting the biceps tendon and then laying a strip of the ilio-tibial band over it. Valuable details of fascial and tendinous transplantations have recently been published by Gallie and Le Mesurier.

Semilunar Cartilages.—A semilunar which has locked the knee for the first time should be reduced, if possible, and immobilized. The prescribed method of reduction is for the surgeon to flex the knee to the extreme, then to abduct the knee and get the patient to straighten it suddenly by a kick. Simultaneously with the kick, the surgeon aids in the extension and rotates the lower leg in a clockwise direction (Jones).

Assuming that the cartilage is an internal one and is obstructing by displacement centrally, either of the whole or a part, the mechanism may be explained as follows: Strong flexion brings the offending tissue into contact with the posterior portion of the internal condyle. Abduction produces a little space between tibia and femur internally, so that the obstruction has a clear path to slip outward. And sudden extension with clockwise rotation screws the tissue outward into its proper place. The sudden extension of the quadriceps, through the medium of the capsule, also tends to jerk the cartilage into its proper place. It should be noted here that the virtue of the sudden kick which so many patients use to reduce transitory lockings, probably lies in the sudden tension thrown

on the joint capsule, which in its turn jerks the cartilage outwards, even though the attachment between capsule and cartilage has been stretched or partially ruptured.

Complete reduction is, of course, an essential, and this condition is certain only when the patient can fully extend his knee actively (Jones). If the patient states that the knee still seems to be obstructed, he is probably right. Ether anaesthesia may make a reduction possible which cannot be obtained otherwise. Long duration of locking is not necessarily a preventive of reduction, and the procedure in such a knee should be the same as with one only a few hours old. It may be necessary to make a number of attempts before the operation is successful, and it may be of advantage to partially reverse the procedure in an obstinate knee, i.e., to rotate the lower leg in a counter-clockwise direction on sudden extension. The various positions assumed by a deranged cartilage explain the necessity for an occasionally modified procedure.

If reduction is accomplished, the knee is immobilized for six weeks. A plaster cast is the most satisfactory agent, but should be bivalved ten days after injury, so that massage can be begun. Weight-bearing is begun after three weeks or more. The patient is instructed to keep the foot turned straight ahead. In addition, his shoe is raised on the inside in order to aid in the production of the varus position. This position saves the internal lateral ligament until it has completely regained its tone.

If reduction is impossible, the cartilage must be removed. Furthermore, in those cases in which the symptoms of "slipping", "catching" or "locking" recur on slight provocation, we consider that the risk to the individual is less from a well-conceived and meticulously performed aseptic operation than from the injuries he is likely to receive from these sudden disablements. These disablements may take place at the exact moment when he is attempting to avoid a danger by a sudden movement, and may make the avoidance of this danger impossible.

We have followed in the main the technique of Sir Robert Jones, who sagely remarks that there is no margin for error in technique in operations on the knee-joint. The limb is shaved from mid-thigh to mid-calf at least 36 hours before the operation, carefully washed and scrubbed with gauze and sterile soap solution, ether, alcohol and biniodide of mercury, and a dry, sterile dressing applied which is retained by a bandage and adhesive plaster. Twelve hours before the operation the dressing is removed by a physician or nurse, whose hands have been scrubbed as for a surgical operation and who wears sterilized rubber gloves. The prepared area is again scrubbed with sterile soap and

water, ether and alcohol. A dry dressing is again applied and bandaged in place.

On the table, a tourniquet or Esmarch is applied. The prepared area is again scrubbed by the surgeon or his assistant after his own hands have been prepared for the operation and temporary sterile gloves put on. The whole limb is carefully draped so that it is free from other covering. Over the knee is placed a single layer of compress cloth wrung out in an antiseptic solution. No iodine is used. The knee hangs over the end of the table. The surgeon seats himself on a stool, with the heel of the bent leg resting on his own thigh, so that he may voluntarily slightly change the amount of flexion by moving his thigh. The incision is made through the compress cloth, which is later clipped to the edges. The line which we have usually employed is a three-inch (7 cm.) lateral and slightly "J"-shaped incision, starting opposite the middle of the patella, extending downward and curving rather sharply away from the mid-line of the limb for about one inch (2 cm.), just distal to the upper border of the tibia.

The knife used in making the skin incision is now discarded and the skin edges swabbed with alcohol. With a fresh knife the incision is continued through the lateral expansions of the vastus internus or externus, and the capsule and synovial membrane opened in this same line, but for only such a distance as is necessary to afford a satisfactory exposure. It will be found advantageous to first dissect away the coronary ligament from the portion of the cartilage which presents, in order to be able to grasp the cartilage firmly from above and below and thus ascertain by gentle traction the nature of the deformity. Careful dissection of the cartilage from its attachments is next carried out. By careful, gentle traction, almost the entire cartilage may be reached, a tenotome and small-jawed, blunt-pointed, long-shanked scissors being useful for this purpose. Under no circumstance should any injury to the lateral ligaments or crucials be done.

The joint is now inspected for tabs or other injuries, and the synovial membrane and capsule closed completely with fine, interrupted sutures. Our own practice has been to employ very fine black silk for this purpose, and we have had thus far no reason to regret the use of this non-irritating, completely sterilizable material. The lateral expansions are closed as the next layer in the same manner, and the skin as the third layer.

At no time during the operation does the operator's finger enter the wound. For any necessary sponging, swabs of sterile absorbent cotton wrung out (by instruments) in sterile salt solution are employed. The

sutures are handled and tied by instruments. Rarely is it necessary to tie any vessels. After the skin wound is closed, the knee is gently extended and a compression dressing applied. The tourniquet is removed and the knee placed on a soft pillow with firm sandbags on either side. Gentle active, painless motion in bed is not forbidden during convalescence, and the stitches are removed in seven days.

By ten days, active motion is encouraged and slight weight-bearing is allowed, if it is painless as it usually is. In two or three weeks, crutches or canes are abandoned and in a month the patient is allowed to resume his former activities.

Patients with recurrent lockings who refuse operation should be watched for the development of arthritic changes, which may become hypertrophic arthritis or tuberculosis (Jones). The non-operative treatment of cases with recurrent locking is a cage splint with a varus position of the foot (Jones and Lovett).

Crucial Ligaments and Tibial Spine.—Stretched or ruptured crucial ligaments are treated by prolonged immobilization, whether they are of recent or remote origin. In the latter case, enough benefit may be obtained to make a decided difference to the patient, and operation may be avoided. In the former case, the prognosis is much better still. If, in a recent injury, the knee is distended with blood, it should be aspirated; and the same applies to severe effusions of any other nature. Otherwise, the effusion tends to produce a general laxity of the ligaments.

The most satisfactory method of putting up the knee is in a plaster cast with the knee slightly flexed. The cast is bivalved—immediately in old cases and after two weeks in recent ones,—and the posterior half only is used. Massage is instituted early, after about ten days. Passive motion is begun after the knee has been immobilized for six weeks or longer and is followed by active motion. The stiffness resulting from the immobilization is found to be only temporary (Jones and Lovett). When walking is begun, the knee is protected by a cage splint for a variable length of time. It is allowed only 20 degrees of motion at first, with subsequent gradual increase in motion. Raising of the inner portion of the heel and sole is advisable in some cases.

If, at the end of the immobilization period, the symptoms of crucial derangement are still so marked as to interfere with function, operative correction may be tried. A fascial or tendinous substitution is made for the affected crucial and for the affected lateral ligament at the same time. This is the operation originated by Hey Groves and modified by Alwyn Smith. If the anterior crucial is involved, a strip of the ilio-

tibial band is run through tunnels in femur and tibia, following the course of the anterior crucial, and on its emergence from the tibial tunnel is drawn up and sutured to the femur near its internal tubercle, thus reinforcing the internal lateral ligament as well. If the posterior crucial is involved, the tendons of the gracilis and semitendinosus are divided and run through the joint in a manner similar to the above, but this time corresponding to the course of the posterior crucial as nearly as is practical.

In our own experience the above is a very considerable operative procedure and is rarely necessary if immobilization has been promptly employed.

Hey Groves believes that the best exposure of the operative field is obtained by means of a "U"-shaped incision, with the lowest portion of the curve below the tibial tubercle. The skin is reflected, the tibial tubercle with its insertion of the patellar tendon removed with a chisel, and the tendon and patella turned upwards. At the conclusion of the operation, the tubercle is fastened in place again by ivory or bone pegs. The knee is immobilized by a posterior splint after operation. Two or three weeks later, massage is begun. Six weeks after operation, the patient is allowed to be up in a light plaster. Finally, motion is allowed in a molded plaster cast with lateral hinges. This plaster is retained until all danger of lateral strain is past, three to six months after operation.

Fractures of the tibial spine, if they can be reduced and the joint fully extended, receive the same treatment as the non-operative crucial ligament cases (i.e., the knee is immobilized in a slightly flexed position). If extension cannot be obtained, the inflammation due to injury is allowed to quiet down and operation then performed. The knee is entered by the split-patellar route and the obstructing piece of bone removed. The post-operative care is the same as that of non-operative cases.

Loose Bodies.—If loose bodies are present and give rise to troublesome symptoms, they should be removed. Even if they produce only mild symptoms, they may be causing gradual arthritic changes and require removal for this reason. X-ray, symptoms, and signs are the criteria by which we decide the question of a progressive arthritic condition.

X-rays in both planes should be taken before operation, so that unsuspected bodies may be discovered. If possible, the body should be brought into a palpable position before anaesthesia, and held there until the operation is under way and the body can be transfixed or removed. If

the body is in the anterior compartment, the procedure to bring this about is to fully extend the knee and then "knead" it upwards, in the hope of pushing the body into the suprapatellar pouch. The knee is kept extended, if this manipulation proves successful, until the body is removed.

A body lying behind the anterior crucial ligament cannot be brought to light in this way, but flexion and torsion of the knee may dislodge it. One of the writers (Osgood) had a case a short time ago which showed one palpable body. The patient, however, stated that at times a second could be felt. The patient's story was believed and an experiment accordingly made on a cadaver to determine the probable location of the other body. Two soap balls were made, one about the size of the palpable body and the other somewhat smaller. Both were introduced into the knee joint of the cadaver through a split-patellar incision, and an attempt was made to "lose" them. It was always possible to bring the larger one into the suprapatellar pouch by extending and kneading the joint. The smaller was finally lost and on exploration of the joint was found behind the anterior crucial ligament.

At operation a few days later, the larger body was easily brought into the suprapatellar pouch and there removed by a small median incision. The operator remarked at this point that he would consider his work incomplete if he did not find the second body described by the patient. He therefore flexed the knee and rotated it. The second loose body then became palpable and was easily delivered from the suprapatellar wound. Thus the splitting of the patella was avoided.

If it is at all uncertain how many bodies are present, the split-patellar incision is the best for exploring the anterior chamber. The popliteal incision (Brackett and Osgood) is usually the best way to explore the posterior chamber. It is a longitudinal incision, just internal to the midline. The vessels and nerves are drawn to the outer side. Postero-lateral incisions have been proposed by Henderson for bodies located in those positions. Both postero-lateral incisions are made with the knee fully extended, the external just outside the biceps tendon and the internal just internal to the tendon of the semimembranosus. After the skin incision has been made, the knee is moderately flexed so as to draw the tendon out of the way and make the capsule readily accessible.

No post-operative immobilization is required unless the split-patellar incision is used. In that case, a plaster cast or posterior wire splint should be kept on for between two and three weeks, and massage of the muscles begun after ten days.

Local anaesthesia is a very satisfactory agent for removing a loose

body which can be easily located and lies free in the joint. McWhorter has even found it satisfactory in removing the semilunar cartilage. In the latter case, the anaesthestic is injected into the joint cavity, as well as into the tissues around the incision.

Hypertrophic Fringes and Fat.—The keynote of treatment in these cases is the protection of the hypertrophied tissue from internal trauma until it can atrophy to its normal size. After this stage is reached, it ceases to be traumatized internally and the condition is cured.

The type of protection employed varies according to the severity of the trouble. Strapping of the anterior aspect of the knee with adhesive tape is sufficient, in moderate cases, to withdraw the affected tissue from between the joint surfaces. A cage splint, with a stop preventing full extension, is necessary in the more severe ones (Jones and Lovett.) In the latter type, extension is limited about 20 degrees at the start, and this figure is gradually reduced as the symptoms improve. It may be necessary to keep the patient off his feet temporarily.

Exercise of the quadriceps extensor increases the pull of this muscle on the capsule during the process of extending the joint. This pull is transmitted to the fringes and fat-pad, as previously described. It is, therefore, a very definite aid in reducing internal trauma. The exercising should, of course, be done without weight-bearing, in order to avoid further injury to the tissues.

If the symptoms remain severe after a reasonable course of non-operative treatment, it is advisable to operate, but this is not often necessary. The incision usually made is just internal to the lower part of the patella, in the case of an hypertrophied infrapatellar pad, and the fatty mass freely excised. It may be necessary to make a similar external incision. No functional disability follows the removal of this tissue (Jones and Lovett).

Hypertrophied fringes are freely removed in a similar manner. The removal of a considerable portion of the synovial membrane with its dependant villi, constituting a synovial capsulectomy, has been revived lately and found to be desirable in certain cases. This type of operation is advocated by Skillern, and has been practised by Baldwin and Swett.

Hypertrophic Bone.—The method of attack in these cases is two-fold, freer elimination of injurious agents and the reduction of intra-articular friction.

Patients with this condition are apt to have a sluggish intestinal activity, which must be improved. Bodily mechanics are of primary import-

ance in bringing this about—improvement in posture with a drawing in of the pendulous abdomen. The abdomen is first supported mechanically, and later by gradually-regained muscular activity.

A bulky diet will produce a more active peristaltic action. Reduction of food elements which putrify readily will reduce the amount of toxic material. Elimination of toxic agents is also sought by means of the urinary tract and the skin. The use of sodium phosphate has been found especially satisfactory because of its combined laxative and diuretic properties.

In addition, elimination of injurious agents at their destination, the joint, is aimed at. Heat, massage, and movement are employed for this purpose. Moist heat and diathermy seem to be the best types of heat to use. Their action is merely the improvement of circulation. Gentle massage and painless motion may serve the same end and, in addition, help to prevent atrophy. General building up of the powers of resistance is also sought by attention to the diet, by rest, and by baths.

The reduction of intra-articular friction is sought by means of adhesive plaster strapping, cage splint, Thomas caliper, leather support, plaster cast, traction in bed, or operation, according to the severity of the case. Operation is occasionally resorted to, in the form of joint excision, to produce ankylosis. This is the most satisfactory means of reducing joint friction in those cases whose only alternative is severe pain and disability. It may not be successful, however, as it leaves pathological bony surfaces in apposition, which may unite with difficulty. An alternative operation, joint erasure, leaves eburnated surfaces in apposition, which unite with much greater difficulty. Operation is much oftener required to remove bony overgrowths which interfere with the joint motion, press upon nerves, or are themselves subjected to painful pressure.

In concluding, stress should be laid on the value of team work between the physician and surgeon, both attacking the toxic element, and the latter looking after the mechanical as well.

PROGNOSIS

With the proper treatment, the general prognosis for recent internal derangements is good, but becomes less and less favorable the older the case before it receives treatment.

Lateral Ligaments.—A recently ruptured lateral ligament will probably heal entirely if protected from strain until it regains its tone. A

relaxed lateral ligament, of long-standing, may improve enough under immobilization to require no further treatment. If operated upon by one of the tendon or fascial transplant methods described, definite improvement may be expected, but often not a complete restoration of normal stability.

Semilunar Cartilages.—A recently deranged semilunar which has been completely reduced and immobilized may give no further trouble. A recent semilunar case which has been operated upon has an excellent prognosis. An old, recurrent semilunar case is usually much improved by operation, but the prognosis varies with the findings at operation. It is less favorable, the greater the arthritic changes. If definite hypertrophic changes are found, the prognosis may be favorably affected by improvement in the eliminative functions of the body. An unoperated, recurrent semilunar is always a care, both on account of the nuisance of wearing a brace and the danger of a recurrence.

Crucial Ligaments.—Recent crucial injuries with prolonged immobilization in good position give surprisingly good results. This means that operative treatment is usually unnecessary. In regard to the Hey Groves operation, we have not personally observed the end-result in any cases. Jones has observed definite improvement in some of them. Old, unoperated crucial cases showing a marked hypermobility, have often only a small amount of disability therefrom (Jones).

Tibial Spine.—Recent fractures of the tibial spine which have been reduced and immobilized will probably give very little trouble in future. If the fractured piece obstructs and is removed by operation shortly after injury, the prognosis is nearly as good. If the injury is accompanied by rupture of a crucial, the outlook is not so favorable. In old fractures of the tibial spine, the range of motion can often be improved and the pain and stiffness markedly lessened by operation.

Loose Bodies.—The prognosis depends on the nature of the loose body. If it is the result of an hypertrophic arthritis, this removal is only a palliative measure. Permanent improvement can be hoped for only if the progress of the disease is checked. If the body is the result of a flaking off of the articular surface, the prognosis is excellent unless it has set up chronic, progressive changes. If the body belongs to the third group—synovial chondromata,—its removal may effect a permanent cure. The prognosis is uncertain, however, because it is impos-

sible to tell whether the condition is progressive or will cease abruptly after operation.

Hypertrophic Fringes and Fat.—Those cases with a traumatic etiology can usually be caused to atrophy to such an extent, by strapping or immobilization, that they give no further trouble. The few cases requiring operation usually give very satisfactory results. If there is a toxic element present, however, the prognosis is less favorable. The operative findings indicate how severe the involvement is, but the outcome is, of course, mainly dependent upon the removal of the sources of intoxication.

Hypertrophic Bone.—It is still somewhat doubtful how much improvement is to be expected from investigation of foci. From local treatment, much may often be expected. The diminution of intra-articular friction causes an abrupt improvement in pain.

The removal of bony overgrowths, which are painful themselves or are causing pain or obstruction, gives definite relief, but no assurance can be given against their recurrence. In our experience, however, there has been no recurrence. The attempt to obtain a stiff joint by excision may not be successful. Joint erasure is even less apt to be successful.

REPORT OF CASES

We shall first review the method used in following up these cases, and then discuss the data obtained. To facilitate the reading of the report, we give the following summary:

A. Method
   - Circular Letters
   - Second Letters to Patients
   - Letters to Friends, Postmasters, Town Clerks, and Overseers of the Poor
   - Interviewing Local M. D.
   - Personal Follow-up
   - Data Already in Records

B. Data
   1. Statistics
      - Percentage of Total Number on Whom Reports Were Obtained
      - Frequency of Operation 1900-1910, Compared with 1910-1920
      - Frequency in the Two Sexes
      - Frequency of Each Type of Case
      - Average Age
   2. Preoperative Data
      - Pain, Locking, Limitation, Swelling, Hypermobility, Duration, Course and Onset, Nature of Onset, Cause of Onset

3. Operative Data
   - Incisions
   - Procedure in Various Groups of Cases, and Pathology Found
4. Postoperative Data
   - Convalescence Time
   - Signs and Symptoms
     - Patient's Point of View; Pain, Locking, Limitation, Swelling, Tiring Easily, and Hypermobility
     - Doctor's Point of View; Pain, Swelling, Bony Overgrowth, Limitation, Hypermobility, Roughness, and Atrophy
   - Results
     - General
       - Our Series
       - Comparison with Those of Others
     - Details of Results in Unusual Cases
       - Sepsis, Tuberculosis, Removal of Both Semilunars, and Ruptured Crucial Ligament
5. Conclusions

A. METHOD

The total number of internal derangements operated upon at the Massachusetts General Hospital between the years 1900 and 1920 was found to be 232. The total number of patients was 228, as several had more than one operation. Each of these patients was sent a circular letter inquiring in detail into the degree of relief obtained, whether the result was considered satisfactory and whether the patient would return to the hospital for examination. An additional question was added later, regarding the time of convalescence.

Only a small proportion answered these first letters, and this fact was explained in part by the long period, in some cases, that had elapsed since the patient had been discharged. Patients had changed their residence, and had not left their new addresses with the Post Office. On investigation, it was found that a number of patients who received the letter failed to reply through apathy. They reasoned that since they were cured, it was not worth while giving the matter a second thought, in spite of our urging them to report in the interests of science as well as self.

The idea might have been put in a clearer, more forceful way, but it is probable that human nature has not changed a great deal since the day long ago when ten lepers were healed and only one—a Samaritan—returned to report! Follow-up work in Samaria might be productive of more rapid results.

By intensive follow-up work—second letters and personal trips to various parts of the city and the suburbs—we were able to see many of these delinquents. In the large number of cases in which the letter was returned unopened, we attempted to follow-up by writing to a friend of the patient, obtaining the address from the hospital records. In certain cases, we also wrote to the local postmaster, the town clerk, or the overseer of the poor. In occasional cases, we interviewed the local M.D.

and found this method very satisfactory. As a last resort, we followed the patient personally from one address to another, and were often able to reach him. It consumed a great deal of time, however, and is of questionable value on this account. We obtained reports on a certain number from follow-up data which had been obtained by others and recorded in the records.

B. DATA

1. *Statistics.*—Reports were obtained on 177 patients out of the 228, or 77.5%. Two patients had had two operations each, and one, three, so that a report was obtained on 181 operations. Only these cases and operations will be considered. In the vast majority of the cases, the interval between operation and the obtaining of the report was two years or longer. In twelve cases, it was between one and two years; in six, it was between three months and one year.

In answer to the question whether the operation is being done more frequently than formerly, we found that—

49% of these cases were operated upon between 1900 and 1910.
51% " " " " " " " " 1910 and 1920.

Of the total, 138 were males and 39 females.

The cases were classified under different diagnoses according to the operative findings. These findings were not always correct, as will be mentioned later.

78	operations	were	performed	for	deranged internal semilunar	(43.1%.)
15	"	"	"	"	" external "	(8.3%.)
41	"	"	"	"	loose bodies	(22.7%.)
25	"	"	"	"	hypertrophic fringes	(13.8%.)
9	"	"	"	"	" fat	(5.0%.)
5	"	"	"	"	" bone	(2.8%.)
3	"	"	"	"	deranged crucials	(1.7%.)
3	"	"	"	"	fibrous bands	(1.7%.)
2	"	"	"	"	chronic arthritis	(1.1%.)

These conditions are all old friends—or rather enemies—of the surgeon, with the exception of "Fibrous Bands." Their nature will be described in the operative data.

The average age at operation was:

Semilunars	31	Yrs.	(Oldest,	64—	Youngest,	12)
Hypertrophic Fringes	33	"	("	64—	"	21)
" Fat	34½	"	("	56—	"	18)
" Bone	53	"	("	73—	"	30)
Deranged Crucials	32	"	("	36—	"	27)
Fibrous Bands	21	"	("	41—	"	9)
Chronic Arthritis	36½	"	("	43—	"	30)

Preoperative, Operative, and Postoperative Data.—Certain general aspects will be discussed. The pre- and postoperative data were not obtained from every patient. In those data obtained from so few cases

as to throw doubt upon their value, a statement is made to that effect. The "six larger groups" referred to in various places are the two semilunars, the loose body, and the three hypertrophic tissue groups. Only these groups are considered in the discussion unless special reference is made to others.

2. *Preoperative Symptoms.*—Pain is seen to be almost universally present throughout.

Locking was present, at one time or another, in all of the external semilunar cases, 82.4% of the loose body, and 79.5% of the internal semilunar. There is a marked hiatus in the frequency of locking between these groups taken together and the hypertrophic tissue groups:

Fat	55.5%
Bone	50.0%
Fringes	33.3%

In regard to the crucials, two of the three showed locking, but the third probably did not. The total number is so small, however, that these figures are worth little by themselves.

The question of preoperative locking brings up a valuable diagnostic point: A young man was admitted with the diagnosis of deranged internal semilunar. He stated that on the previous day he was kneeling to catch a ball when he felt something snap in his knee. On attempting to rise, he found that sudden weakness had developed in the knee, and that he was unable to rest any weight upon it. He was carried home. He came to the hospital the following day and was admitted at once.

According to the patient's statement, there had been no locking; physical examination also revealed none. The knee could not be straightened voluntarily, but the examining surgeon reported that it could be straightened passively. (There was probably failure on his part to distinguish between extension and hyperextension.)

Operation one week later revealed the anterior end of the internal semilunar dislocated and locking the joint.

The missing of this point before operation was of no consequence in this particular case, as the cartilage was removed, but it would be of marked importance in such a case if a non-operative procedure were employed. It would result in permanent obstruction to full extension, from the dislocated cartilage.

A story of prolonged flexure suggests a persistent locking. The question can be settled definitely by adopting voluntary, complete hyperextension as the criterion of complete reduction.

Limitation of Motion.—This refers to limitation exclusive of locking. These two types of interference were carefully distinguished. In limitation of motion, the hypertrophic trio heads the list:

Hypertrophic Bone	85.7%
" Fringes	56.5%
" Fat	44.5%

The semilunar and loose body groups all fall below these percentages:

External Semilunar	33.3%
Internal "	21.0%
Loose Bodies	18.4%

Swelling.—Five of the six larger groups had swelling as a symptom in over two-thirds of the cases:

Internal Semilunar	83.6%
Loose Bodies	75.7%
Hypertrophic Fat	75.0%
" Fringes	73.9%
External Semilunar	69.2%
Hypertrophic Bone	57.1%

It was a feature of all the crucial cases, as we should expect.

Hypermobility.—This symptom is headed by the group subject to the severest trauma—the crucials. The second place is occupied by the next most severely traumatized group—the internal semilunars:

Crucial Ligaments	66.7%
Internal Semilunars	11.1%
Loose Bodies	8.1%

The other four had no case showing this symptom. In regard to the external semilunar group, the implication may be that the agent causing this derangement is not so apt to injure the lateral ligament on that side as it is in the case of the internal cartilage.

In regard to the crucial group, the question arises why one of them failed to show hypermobility. This case had a ten-year duration of trouble, which resulted from stopping suddenly while running. The patient stated that the leg seemed to go out from under him simultaneously with the onset of sharp pain. He did not remember any torsion. Limitation of extension resulted, but its duration is not stated. There were many subsequent attacks, usually following a minor injury, always with limitation of extension and with sudden terminations. Examination showed a slightly recurved position of the knee, slight puffiness just external to the patellar tendon, and tenderness in this area. Extension was possible beyond a straight line, and flexion beyond a right angle. The unaffected knee was also recurved and had localized swelling external to the patellar tendon.

X-ray of the affected knee showed a slight tendency to hypertrophic changes, but nothing else.

We should have expected to find a deranged semilunar cartilage and an hypertrophied fat-pad at operation, and should not have expected to find a crucial involvement. The findings were a complete rupture of the anterior crucial ligament and an hypertrophied fat-pad.

It is impossible to reconcile these preoperative and operative data.

Duration of Present Illness Between Onset and Operation.—The duration of illness varied a great deal in all of the larger groups, but in the majority of cases it was under three years. We therefore group those under three years and those of three years or more separately; we also subdivide the latter group when indicated. The following table gives the average duration of present illness in those cases of less than three years' standing:

(1)

External Semilunars—Less than 3 yrs.—Average,	12.3 Mos.
Hypertrophic Fringes	10.8 "
Loose Bodies	8.8 "
Internal Semilunars	8.4 "
Hypertrophic Bone	8.3 "
" Fat	6.4 "

The second table gives the percentage of the total in each group, which had a duration of less than three years:

(2)

Loose Bodies —Less than 3 yrs.—	56.1%
Hypertrophic Bone	60.0%
" Fringes	60.0%
Internal Semilunars	78.4%
External "	80.0%
Hypertrophic Fat	87.5%

If we consider the cases of less than three years' duration in each group, we find that the average duration is as given in Table (1). If we consider the numerical relation of these cases to the total in each group, we find that the percentage is as given in Table (2). There is a marked incompatibility in the two tables regarding the external semilunar, the hypertrophic bone, and the hypertrophic fringe groups. The external semilunar group is at the top in the first table, but next to the bottom in the second. Perhaps the symptoms in the external semilunar derangements were not severe enough to call imperatively for early relief, for although locking was present in 100%, yet swelling was experienced by only 69%,—the next to lowest of all the six groups. In regard to the low rank of this group in the second table, we may imagine that the symptoms, although not severe, were persistently recurrent and caused 80% of the patients to give up the fight before three years were up, and seek relief. The low rank of the hypertrophic bone group in the first table is probably a matter of chance. One of the three cases which made up this average had a duration of only one month, although giving a history of rheumatism for years. The discrepancy in the hypertrophic fringe group cannot be explained. Five of the fifteen cases of less than three years' standing had durations of five months or less, and they are responsible for bringing the average so low.

Course.—In the internal semilunar group, over half of the cases had progressive symptoms. In the other five groups, a still larger number were progressive—between 70% and 80%.

Cause of Onset.—This was unknown in only 11.7% of the internal semilunar group. It was unknown in the majority of hypertrophic bone cases. In the other four, it lay between 30% and 40%:

Hypertrophic Bone—Cause unknown	80.0%
External Semilunars	39.0%
Fringes	36.0%
Loose Bodies	34.2%
Hypertrophic Fat	33.3%
Internal Semilunars	11.7%

Nature of Onset.—Over 90% of both semilunar groups had a sudden onset. Another interesting point is that hypertrophic fat is apparently more apt to cause a sudden onset than are fringes. Hypertrophic bone produced no sudden onsets:

Internal Semilunars, Sudden onset	94.9%
External " " "	92.9%
Loose Bodies " "	80.0%
Hypertrophic Fat " "	77.8%
" Fringes " "	52.0%

(3.) *Operative Procedure; Incisions.*—The lateral approach, with the lower end of the incision often being continued horizontally for a short distance, was employed 158 times. It was used in combination with the popliteal in one of these cases. Mitchiner has found that it produces a localized anaesthesia in a large number of cases, and tenderness on kneeling in some. Our cases have not complained of these features, but have often had very slight tenderness over the scar.

The split-patellar incision was used in 21 cases of our series, and in only two of these is there any chance of its having caused symptoms. In one of these we should say it was probably not at fault, and in the other, that it was, perhaps, partly at fault. In looking for loose bodies, we believe the split-patellar incision to be the best, unless the bodies can be readily localized in parts of the joint requiring only a small incision. We have two cases in mind which were approached by the lateral incision. One showed a loose body palpable on examination, but failed to reveal it at operation. The other was considered to be a case of osteochondritis dissecans, and had a history of injury followed by a free interval, with subsequent recurrent locking and swelling. Exploration revealed only hypertrophic fringes, which were removed without benefit. A split-patellar incision would have offered a much better view of the joint, with the possibility of revealing loose bodies or other pathology.

Procedures in the Various Groups; Pathology Found.—Of all the 93 semilunar cases, there were only two in which nothing was done on

entering the joint. In both these, the cartilage seemed normal. Both patients had subsequent trouble, went to other doctors, and were cured. The one had the semilunar removed, the other does not state whether she had an operation or not. These cases bear out the wisdom of Sir Robert Jones's advice as to removing the cartilage even if it appears normal, providing the preoperative diagnosis seems definite.

At least one of the two patients just mentioned above had locking after the first operation. Six others of our postoperative semilunar cases complained of it. The following melancholy data of operative procedures explain the recurrence of locking in six of these seven cases:

(1) Nothing removed.
(2) Excision, fragment of cartilage anterior to semilunar.
(3) Excision, loose flap coming from semilunar.
(4) Excision, two torn pieces of semilunar.
(5) Partial excision and suture of semilunar.
(6) Excision, anterior third of semilunar.
(7) Excision, semilunar.

In the seventh case the locking did not recur until at least eight years after operation, thus probably exonerating the operative procedure from responsibility.

In the loose body group, there was only one case in which nothing was found to account for symptoms. This case unquestionably had a free body in the joint, as it was palpated on entrance. It must have become attached to the synovial membrane or become lodged in a recess of the joint after operation, as it never gave trouble afterwards.

One case in this group gave a very interesting pathological picture. The patient was a young man with a history of trauma to the knee. Six months previous to entry, he had stepped off the edge of a trench during a sham battle and had landed on the opposite slope with his right knee flexed to a right angle. In landing, he struck his knee against his rifle. He had severe pain as a result, and was unable to bend or straighten his knee completely. After a few minutes, however, he was able to get up and hobble to his tent. The following day, swelling and extreme tenderness developed.

He was sent to hospital, where he remained three months. The treatment consisted of massage and the application of liniments. He went back to his work as a scale maker, one month after discharge, in spite of the persistence of symptoms. Two months later he entered the Massachusetts General Hospital.

At operation, a defect was found in the femoral articular cartilage on the external aspect of the medial condyle, extending posteriorly to the attachment of the posterior crucial, which was slightly torn. The defect was lined by a smooth, fibrous coat, except at the anterior margin, where it was ragged. Upon retracting the ligamentum mucosum, two loose bodies were seen, one, 2x1 cm., in the midline and apparently attached by a tab of tissue to the posterior crucial ligament; the other, 1x1 cm., lying free in the lateral portion of the joint. Corresponding to the smaller

body was a defect on the internal aspect on the external condyle, slightly invading the attachment of the anterior crucial ligament, which, like the posterior, was slightly torn.

This description was written in 1916, six years before the theory was published by Fisher, that such a condition is due solely to sudden tension on the crucials.

In some of the hypertrophic tissue cases which had an unsatisfactory result, we reviewed the operative findings with the idea of seeing whether this prognosis could have been made at operation. Apparently it could not, as the joints varied a good deal in appearance. One, which showed only a slight villous hypertrophy, continued to give more and more trouble postoperatively, until the patient had two subsequent operations at another hospital, neither of which helped her. The patient was described as, "A fat woman, not of marked intelligence," and may have had abnormal internal glandular activity. Fisher believes we may find this internal glandular element to be a causative factor in some cases of hypertrophic arthritis. In the succeeding operations, this patient showed adhesions, but there is no mention of an hypertrophic arthritis, except a roughened area on the under surface of the patella. In contrast to this, another knee showed extensive pathology: "Hypertrophic synovial membrane hung in short, thick folds from the quadriceps pouch . . . there were velvety, granular thickenings on the lateral and inferior portions of the synovial sack." This case had a satisfactory result, although motion was limited.

The conclusion is, therefore, that the average case which gives an unsatisfactory result, does so because there is a progressive postoperative process. The possible traumatic source of this down-hill course has been removed by operation, and leaves the toxic element as the still-active agent. The logical procedure in such cases, therefore, is to remove all possible foci and to reduce joint friction, on the assumption that the tissues are still inflamed.

In the villous group, only one case is listed as having had nothing removed, but in a certain percentage of these cases, the amount of villous material removed was so small that the operations were little more than explorations. One case is listed as having had a free body removed, but the operator apparently considered the villous element to be so much more prominent that it was diagnosed villous arthritis.

In the hypertrophic bone group, one case had only fat and fringes removed. It was clearly a case of hypertrophic arthritis, but the soft tissues were the only obstructing elements that could be found.

In the cases of crucial injury, two had a suture of the whole ligament and one, a partial suture. Results in the cases of suture of the whole ligament were: one very satisfactory and the other poor. The latter did not have hypermobility after operation, but did have tenderness, bony overgrowth, and marked limitation of motion. With hypermobility ruled out as the probable cause of the unfavorable result, we look to the severity of the original injury as being the most likely explanation. In the light of our present knowledge, if the disability persisted in spite of usually successful conservative measures, the surgeon might well con-

sider a Hey Groves fascial or tendinous transplant, in preference to suture, because of the friable character of the torn ends.

In the cases of "Fibrous Bands," the operative pictures show a band or cord stretching partially across the joint, but in no constant position, and described in one case as an eighth or a quarter of an inch in diameter. The histories of two cases definitely indicated derangement; that of the third did not. The records of the first two state that the tissue was excised; that of the third makes no statement, but excision was probably done. Results in all three were very satisfactory.

One case was of interest from the diagnostic and pathological standpoints, but was not a real internal derangement and so was not included in the series. The operative finding was a fibrous tumor, extra-articular, but attached to the external semilunar cartilage. The history was that of a protracted disability of two years' duration. The trouble began as a small swelling on the outer side of the knee without a known cause, and was followed two months later by stiffness and swelling. These symptoms were recurrent and the swelling was probably persistent, although there is no definite statement about it.

An operation had been performed six months before entry, consisting of the curettage of a bursa or cyst at this point, but without relief from swelling.

The condition was evidently a cystic growth attached to the semilunar cartilage, with evacuation at the first operation and removal at the second. The patient made a very rapid recovery following the second operation and was entirely relieved. Phemister considers this condition a cystic degeneration, and finds it identical with "ganglia" of the wrist and other parts.

(4.) *Postoperative Data; Convalescence Time.*—We obtained this information from less than half of the total number of cases. The point was not suggested until we were partly through with the work. In averaging these figures, we omitted those in which the figure was so large that it was out of all proportion to the average case. We believe that the average thus obtained gives a more accurate idea of the time required for convalescence.

The average time for semilunars—three and four-fifths months—is several times the average for private practice—one month. It may be that the private case spends more time and effort in regaining strength and motion.

Considering the loose body group in two sub-groups, those diagnosed "osteochondritis dissecans" and those not so diagnosed, the convalescence time in the former was eight months and in the latter two and two-fifths months. The former is a comparatively small group, however, and brings the average for the whole fifteen cases only up to three months. This disparity may possibly be due to the degree of injury to the femoral articular surface. All of the five cases going to make up the eight months average show definite injury to the articular surface or "the condyle," by which the articular surface is probably meant.

In the hypertrophic fat cases, the time required, three and a quarter months, was only half that required in the hypertrophic fringe, six and two-fifths months. The information in the former group, however, was obtained from only two cases.

In the hypertrophic bone cases, the time was excessively long, but it would probably have been reduced if information had been obtained from all the cases in the group.

Postoperative Signs and Symptoms.—We shall now review the postoperative signs and symptoms, first from the patient's point of view, then from the doctor's:

Postoperative Pain.—This column shows a vast improvement over the preoperative pain, which was almost universally present at one time or another. A greater proportion of the semilunar cases were relieved than of any other type, and a good deal larger percentage of the external than the internal were free from all postoperative pain. In contrast, all the hypertrophic arthritis cases had some pain.

Postoperative Locking.—This symptom was wholly wiped out in all of the external semilunar, hypertrophic fringe, and hypertrophic fat cases. The result was not so favorable in the internal semilunar group, with seven cases out of seventy-eight showing postoperative locking. Six of these did not have enough of the cartilage excised. The details have been given under "Operative Procedure."

Two of the external semilunar cases probably illustrate the same point,—the value of taking out all of the cartilage that is accessible. These two cases feel a momentary "catch" on flexing the knee to a certain extent, and this catch is also palpable to the examiner. It feels as if cartilage were slipping over a ridge of cartilage, and is presumably due to the edge of the remaining fragment of semilunar.

Postoperative Limitation.—All groups were improved in regard to this symptom, with the exception of loose bodies. In this group, the percentage of cases affected was actually higher than before operation. Examination in detail of the group shows that the cases diagnosed osteochondritis dissecans supply five of the nine cases affected. There were only eleven cases in all with this diagnosis out of the forty-one cases in the group. The injured articular surface is perhaps the malignant feature, as may also have been the case in regard to convalescence.

Postoperative Swelling.—There was marked improvement in this symptom in all groups except that of the hypertrophic bone. Curiously enough, this group had the lowest percentage of all in preoperative swelling, but, retaining the same figure—57.1%—had the highest percentage after operation. Apparently, operation was not able to affect this group at all in regard to swelling.

Postoperative Tiring Easily.—Every group had a certain percentage of these cases, ranging from 20% in the internal semilunar to 85.7% in the hypertrophic arthritis.

Postoperative Hypermobility.—Only three of the groups had cases complaining of this symptom:

Hypertrophic Bone	20 %
Internal Semilunars	6.7%
Loose Bodies	6.3%

In discussing this symptom, the internal semilunar group interests us most, because of the production of hypermobility at time of injury in certain cases and its occasional production in the course of operation. Three of the four cases complained of preoperative hypermobility.* In the fourth case, the incision was an internal one, and may have partly divided the internal lateral ligament. The local M.D., however, who examined the case for us, could not find any abnormal movement. The results on all four of these cases were unsatisfactory, being considered only "Fair" by the patients. These results should probably be attributed to a loose internal lateral ligament in three cases, and to a deep sepsis with a question of joint involvement in the fourth.

Postoperative Signs and Symptoms from the Examining Doctor's Point of View.—The "Doctor" in most cases was one of the writers, but his colleagues examined some, and the local doctor, others. In certain symptoms, the percentage from the doctor's point of view is universally lower than from the patient's. This discrepancy is easily explained, inasmuch as the doctor saw the patient on only one occasion, while the patient was referring to his whole postoperative experience.

Postoperative Pain or Tenderness.—The semilunars and loose bodies were the best off in this respect, and the hypertrophic bone cases the worst.

Postoperative Enlargement or Swelling.—The hypertrophic bone cases were the only group seriously affected by this symptom.

Postoperative Bony Overgrowth.—All the groups showed a 33.3% involvement, or more, but the overgrowth was not apt to be a disabling one. For instance, of the five external semilunar cases, which had a certain degree of bony overgrowth, all had a very satisfactory result.

*The examination data are not very satisfactory. In regard to the case which did not complain of hypermobility before operation, there is no statement of the corresponding physical finding. In regard to the other three, one had no statement, one was found to have no hypermobility, and the third probably had hypermobility.

Postoperative Limitation.—Only those cases in which flexion to 90° was impossible or in which extension was limited over 5°, were included under this heading. The lowest percentage was in the semilunars—12.5%; the highest, in the hypertrophic bone—83.3%. In the other groups, it ranged between 30% and 43%. The limitation was seen not to bear a definite relation to the bony overgrowth.

Postoperative Hypermobility; (Lateral and Antero-Posterior).—Comparing these figures with those of hypermobility as complained of by the patient, we see that in five of the groups the examiners found it more frequently than the patient complained of it. In the sixth, the symptoms were neither complained of nor found in any case. Apparently, slight hypermobility is often not noticed by the patient. It was not above 15% in any group except that of hypertrophic bone.

Postoperative Roughness.—By this is meant a bony grating on motion, or a feeling as of soft tissues being interposed. The figures indicate that it bears a certain degree of relation to bony overgrowth and to limitation.

Postoperative Atrophy or Hypertrophy of the Affected Limb.—We considered only a difference in circumference of half an inch or more, in measuring the calves and thighs, as constituting an atrophy or hypertrophy. Assuming that in unoperated individuals, the percentage of right leg hypertrophies over the left is equal to that of left over right, we find that the internal semilunar cases do not show any postoperative atrophy, but that both the loose body and the fringe cases do. The figures in the other groups are not satisfactory for drawing conclusions, because of the small number of cases contributing to these data.

Results, General.—Under "Very Satisfactory," we group those cases which were able to return to their regular work, with no difficulty of any account, or with none whatever. Under "Good" we group those able to return to their regular work, but with a troublesome disability. Under "Fair," we group those which were not able to return to their regular work, but which were improved to some extent by operation. Under "Poor," we group those cases which received no benefit at all.

An objection to this scheme of classification is that certain knees underwent such extensive changes before coming to operation, that they could not possibly give a very satisfactory result. But a classification from the other point of view,—i.e., considering the possible operative improvement in each case,—would be still less clear.

In cases in which doctor and patient disagreed about the value of the result, the classification is made according to the doctor's decision, but directly beneath, in parenthesis, are placed two results side by side. The first shows the doctor's opinion; the second, the patient's. A number before the letters indicates the number of such cases. E.g., (2 P—F) means that in two cases, the doctor considered the result poor, while the

patient considered it fair. There were five such cases, and in all of them the patient considered the result more satisfactory than the examiner did. Our results in detail, follow:

Internal Semilunars	64	Cases	(83.1%)—Very Satisfactory.
	3	"	(3.9%)—Good.
	1	"	(1.3%)—Fair.
	9	"	(11.7%)—Poor.
			(3P-F)
External Semilunars	14	"	(100%)—V. S.
Loose Bodies	34	"	(82.9%)—V. S.
	4	"	(9.8%)—G.
	2	"	(4.9%)—F.
	1	"	(2.4%)—P.
Hypertrophic Fringes	12	"	(48.0%)—V. S.
	4	"	(16.0%)—G.
	1	"	(4.0%)—F.
	8	"	(32.0%)—P.
			(P—G)
			(P—F)
Hypertrophic Fat	5	"	(55.6%)—V. S.
	1	"	(11.1%)—G.
	2	"	(22.2%)—F.
	1	"	(11.1%)—P.
Hypertrophic Bone	0	"	(0.0%)—V. S.
	2	"	(40.0%)—G.
	0	"	(0.0%)—F.
	3	"	(60.0%)—P.
Deranged Crucials	2	"	(66.7%)—V. S.
	0	"	(0.0%)—G.
	0	"	(0.0%)—F.
	1	"	(33.3%)—P.
Fibrous Bands	3	"	(100%)—V. S.
Chronic Arthritis	1	"	(50.0%)—V. S.
	0	"	(0.0%)—G.
	0	"	(0.0%)—F.
	1	"	(50.0%)—P.

The external semilunars all had very satisfactory results except one, in which the result could not be ascertained, as the patient developed a fresh trouble after operation. Loose body cases gave the next most satisfactory result, closely followed by the internal semilunar. The results in the fringe and fat cases were not nearly so satisfactory, and in the hypertrophic bone there were no very satisfactory results.

It is interesting to compare results obtained by investigators of similar cases elsewhere:

D'Arcy Power, in a questionnaire which he sent to postoperative semilunar cases in 1911, asked the question, "Has there been any return of symptoms?" In 82% of the replies, the answer was "No." In Hen-

derson's series, published in 1917, the internal semilunars on which a report was obtained showed a cure in 68.2%. In Strahlman & White's series of internal and external semilunars, published in 1921, 86% were completely satisfied with the result of operation. Our series shows about the same figure,—85.7% of very satisfactory results. Mitchiner, in an inquiry which he made last year, found that 95.9% of the semilunar cases were able to go through their ordinary, every-day life without any trouble. Figures in his other types of cases are given below and are compared with ours. Mitchiner's figures represent the percentage of cases which had no trouble with the knee during their regular work. Ours represent similar cases, combined with cases troubled slightly in one way or another:

	Mitchiner	S. & O.
Loose Bodies	82.6%	82.9%
Hypertrophic Fringes	81.3%	48.0%
Crucial Ligaments	100.0%	66.7%

Details of Results in Unusual Cases; Sepsis.—There were four cases of superficial sepsis and two of deep sepsis in the series. Of the deep, one did not involve the joint, and it is a question whether the second did or not. In the latter case, the wound was opened five days after operation because of indications of sepsis, but the culture taken was negative and the drains inserted were removed permanently two days later. The former case got a very satisfactory result ultimately, but the convalescence time was eleven months. The latter obtained only a fair result, probably due to joint sepsis or to the secondary operation with the introduction of wicks for suspected sepsis.

Four of these cases had a one-day preparation, one probably had a one-day preparation, and the sixth case is doubtful regarding the preparation as there was no note about it.

Tuberculosis.—Three cases in the series turned out to be tuberculous. In one, a movable semilunar was excised. At a subsequent operation on the same case, thickened villi were excised, examination of which revealed tuberculosis. In the second case, hypertrophic villi were excised. Pathological examination revealed tuberculosis, the symptoms recurred, and the joint was excised three months after the first operation. In the third case, serous fluid was evacuated and the joint washed out. Later, a diagnosis of tuberculosis was made from the persistence and type of the symptoms.

Examination of the operative notes on those cases indicates that the correct diagnosis could not have been made by primary operative findings, but the histories in all three cases were a little suggestive. Graduated doses of tuberculin injected subcutaneously might have revealed the real nature of the trouble. The excision of specimens at operation is, of course, very valuable.

A troublesome knee of long standing, which has been subject to recurrent pain, tenderness, swelling, and effusion and which has caused some

atrophy of the leg, is a fit subject for investigation regarding tuberculosis.

Removal of Both Semilunar Cartilages.—Two cases had both cartilages removed. One of these complains of weakness and giving way of the knee and is obliged to keep it constantly bandaged. The alternative explanations seem to be, a general ligamentus relaxation and the fact that both cartilages were removed. Our information in regard to the second case is not detailed enough to throw light upon the problem.

Rupture of Crucial Ligament with Fracture of Tibial Spine.—This case illustrates the result of immobilization for only a short period.

A ham-splint was applied upon entry, but had been removed by the fifteenth day, and a Bender bandage substituted. The note made on this date also states that the patient was walking with difficulty. Massage had been begun on the eighth day.

The result was not very satisfactory. The patient worked for a month after discharge and was then obliged to stop on account of disability in the knee. She entered the hospital again, two years after the first entry, and was operated upon. A partial suture of the anterior crucial ligament was done.

The patient finally obtained a very satisfactory result, but would have had a prompter and better recovery if she had had prolonged immobilization on her first entry.

C. *Conclusions.*—We repeat the statement that references to the groups in general apply only to the six larger groups, unless otherwise stated.

Method.—Letters to the patient and various other individuals are the first line of offensive attack on the end-result problem. Personal follow-up is the second.

Data; Statistics.—A large percentage of postoperative cases can be followed up, even though they cover a twenty-year period.

In our series, the frequency of operated cases was only slightly greater between 1910 and 1920 than between 1900 and 1910.

Preoperative Data.—Locking is much more common in the semilunar and loose body groups than in the hypertrophic tissue groups.

Limitation of motion is more common in the hypertrophic tissue groups than in the other three.

Complete, active hyperextension is the only satisfactory criterion of complete reduction.

Swelling is a common complaint in all groups.

Hypermobility is complained of most frequently in the groups subjected to the severest trauma, with the exception of the external semilunar group. The implication may be that the external lateral ligament is not so prone to injury as the internal.

External semilunar injuries seem to be less troublesome to the patient than those of the internal semilunar.

In the majority of cases throughout, the symptoms are progressive.

Hypertrophic fat is apparently more apt to cause a sudden onset of symptoms than are hypertrophic fringes.

Operative Data.—If the knee is operated upon for a deranged semilunar, as much of the cartilage should be removed as possible, regardless of a normal appearance. The only exception to this rule occurs when sufficient pathology is found, exclusive of the cartilage, to account for the symptoms.

The lateral "J"-shaped incisions are, in our opinion, ordinarily preferable. The mid-patellar incision is preferable in loose body cases in which the bodies are in the anterior compartment, but are not readily accessible.

The space behind the anterior crucial ligament should be investigated if the presence of a body is suspected in addition to the one or ones already found.

Postoperative Data.—Many hypertrophic tissue cases that have a poor result are probably suffering from progressive local intoxication. Investigation in that direction and reduction of joint friction is indicated rather than subsequent operation.

The convalescence time of semilunar cases, and probably of internal derangements in general, is longer in a general hospital than in private practice.

All groups show a certain percentage of cases that tire easily. The lowest percentage in our series was in the semilunar group, with 20%.

Slight hypermobility is often not noticed by the patient. However, in those semilunar cases in which it is noticed, definite disability is apt to be an accompaniment.

A certain percentage of cases in all of the groups, and hypertrophic bone cases especially, show localized pain or tenderness on examination.

A third or more of the cases in each group show bony overgrowth about the knee, but the patients often are not aware of it.

There is some relation between the incidence of roughness and limitation, and between that of roughness and bony overgrowth, but little relation between the incidence of limitation and bony overgrowth.

In the loose body and hypertrophic fringe groups, at least, a certain percentage of cases show some atrophy of the affected leg.

In our series, external semilunar cases gave the most satisfactory results. Internal semilunar and loose body cases came next. Hypertrophic fringe and fat cases were not nearly so satisfactory as the three preceding. Hypertrophic bone cases gave no "Very Satisfactory" results.

The cases reported by Mitchiner from St. Thomas's Hospital, London, covering the period from 1911 to 1922, have given the most satisfactory semilunar results to date.

A two-day preparation for operation should be used as a prophylactic against sepsis.

Cases that are at all suggestive of tuberculosis should be investigated for this possibility.

Suggested Outline for Records of Internal Derangements of the Knee

1. Past History—Old injuries or inflammations.
2. Present Illness.
   - A. Complaint
     - Pain—Nature, location, and whether constant or remittent.
     - Locking—Whether momentary, repeated, or permanent; whether reduction is easy or difficult, and exact procedure in reduction.
     - Limitation—Distinguished carefully from permanent locking.
     - Swelling—Whether persistent or remittent and whether associated with other symptoms, such as locking.
     - Hypermobility—Distinguished carefully from instability.
   - B. Duration
   - C. Course
   - D. Onset
     - Cause—Whether due to torsion, trauma, some other mode of injury, or to infection. If due to torsion, whether lower leg was rotated clockwise or counter-clockwise.
     - Nature—Whether sudden, rapid or slow.
3. Physical Examination
   - A. Inspection—Including details of any abnormal appearance.
   - B. Palpation—Presence and location of tender point. Presence of fluid, thickened capsule or bony overgrowth. Consistency of swellings.
   - C. Joint Motion—Presence of hypermobility, locking, limitation or roughness of motion. If hypermobile, whether it is in the antero-posterior or the lateral direction. If in the antero-posterior direction, whether tibia can be displaced forwards or backwards on femur.
   - D. Mensuration—Of thigh, knee and calf,—both legs.
4. Operative Notes
   - A. Exact location of incision.
   - B. Appearance and amount of synovial fluid. Appearance of synovial membrane, semilunar cartilages, crucial ligaments and articular surface, especially that of femur.
5. Postoperative Notes
   - A. Nature and duration of immobilization, if any.
   - B. Number of days before starting massage.

C. Number of days before starting motion.
D. Number of days before starting weight-bearing.
E. Number of weeks before regaining full function.

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THE PERIOSTEAL BLOOD SUPPLY AND HEALING OF FRACTURES

Experimental Study

BY ANATOLE KOLODNY, M. D.

Iowa State University, Iowa City

The importance of the intraossal blood vessels in healing of fractures has been emphasized by many authors; but they have all ignored the blood supply of the periosteum. It was Lexer who first suggested the importance of the periosteal blood vessels in the normal healing of fractures.

When this study was begun our hypothesis was: If the periosteum is the foremost osteogenic factor in the regeneration of bone, the blood supply of the periosteum should be of the foremost importance in the normal healing of fractures. To prove this hypothesis we conducted two series of experiments. All experiments were done on adult dogs. The first series numbered nine experiments, which were done as follows: An incision about three inches long was made along the internal margin of the radius through the tissues covering the periosteum of the bone. Over an area of about six cm. we separated all the soft tissues surrounding the periosteum of the radius. Carefully, not denuding the bone of its periosteum, we produced a fracture by means of a Gigli saw. The bone was always fractured in the middle of the shaft of the radius or in some portion of the distal half. The wound was closed with cat gut and a cast applied. X-ray examinations were made 14, 21, 28, and 42 days after the fracture.

The second series consists of five experiments on five dogs. These experiments differed from those in the first series only in that the location of the fracture was in the distal portion of the proximal third of the radius where the nutrient artery enters the bone. To make a complete separation of the tissues from the periosteum in this place it was necessary to divide the nutrient artery just above its entrance into the bone. Thus the fracture was produced through the entrance of the nutrient artery.

Figs. 1 and 2 are diagrams which attempt to demonstrate the relation of the radius with its intact periosteum to the soft tissues before and after separation is made between the two.

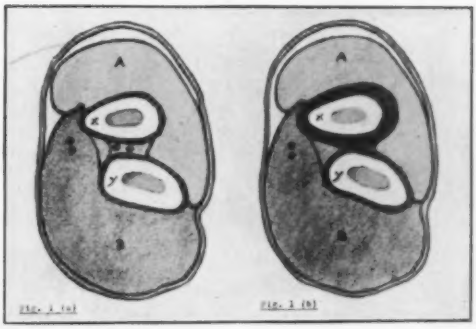

Fig. 1. Diagram of a cross section of the forearm of a dog slightly above the entrance of the nutrient artery into the radius. (a) Before separation of the soft tissues from the periosteum. (b) After separation of the soft tissues from the periosteum.

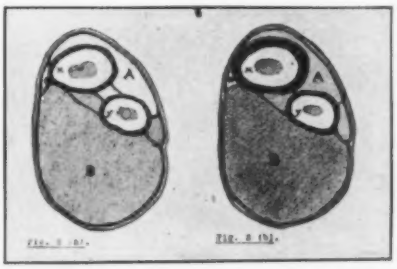

Fig. 2. Diagram of a cross section of the forearm of a dog between the third and fourth quarter. (a) Before separation of the soft tissues from the periosteum. (b) After separation of the soft tissues from the periosteum.

The results of the experiments of both series are shown in the reproductions of the X-ray plates accompanying this paper. Fig. 3 shows a control: a fracture of the radius was produced in an adult dog by the same method as in the series of experiments, except that the tissues covering the periosteum were not separated from it.

DISCUSSION.

We see from the figures that there was no union in any one of our experimental fractures. As we know, we may have non-union because of the lack of callus formation, or, even in the presence of callus we may have non-

FIG. 3

FIG. 4

Fig. 3. Normal adult dog. Open fracture of the radius without separation of the soft tissues from the periosteum. 42 days after fracture.

Fig. 4. Normal adult dog. Open fracture of the radius with separation of the soft tissues from the periosteum. 14 days after fracture.

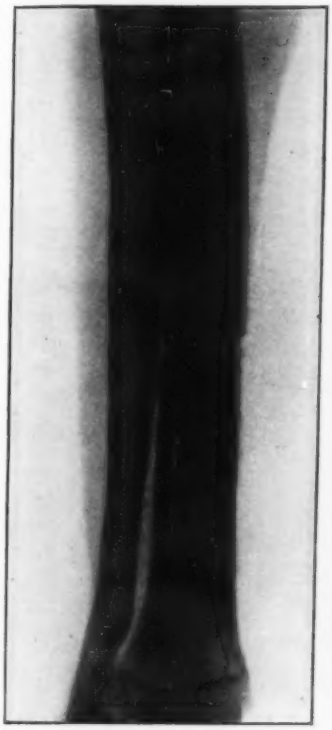

FIG 5

F.G. 6

Fig. 5. The same as fig. 4. 21 days after fracture.
Fig. 6. The same as fig. 4. 28 days after fracture.

union due to deficiency of ossification of the callus or to an early ingrowth of fibrous tissue between the bone ends. Disturbances of endocrine glands should be frequently considered as the etiologic factor in cases where there is lack of ossification of the callus. This I tried to point out in my paper, "Endocrine Disturbances and Non-Union of Fractures." In our experiments of the first series we have a marked exuberance of well ossified callus, but in spite of this no union has taken place. What then were the causes of this abnormality? The healing process in a fracture of a normal bone begins with periosteal callus formation. The endosteum is not able to participate in the callus formation until the intraossal blood circulation recovers by formation of an anastomosis between the central portion of the nutrient artery and the

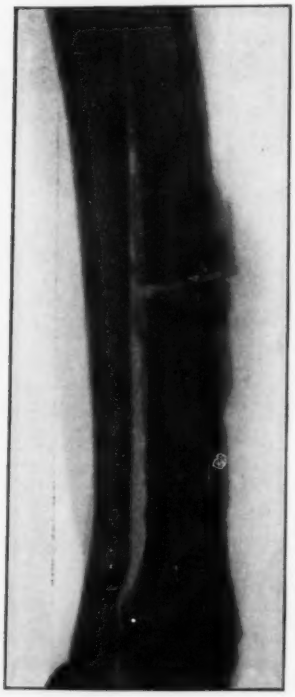

Fig. 7. The same as fig. 4. 42 days after fracture.

metaphyseal blood vessels. Only after this anastomosis has formed does the endosteum begin to produce endosteal callus. In our cases, in the first series, the periosteal blood vessels have been destroyed by the separation of the surrounding tissues from the periosteum. The periosteal osteogenesis could not take place until the blood supply of the periosteum had returned to normal. The endosteal osteogenesis, as is always the case in fractures, could not begin before the intraossal circulation recovered. In fact, fig. 4, 14 days after fracturing does not show as yet any evidence of callus formation. Profiting by these conditions, the always competing connective tissue grows into the vacant space between the bone ends and forms a fibrous septum. Later, when the periosteum recovers and begins to produce callus, this fibrous septum is in the way of the callus and leads to a partial absorption of the bone ends and finally to non-union and pseudoarthrosis. Figs. 6, 7, 9, 10, 11.

Fig. 8 is especially interesting. The dog in this case removed his cast on the first day after the fracture, pulled out the sutures, and opened the wound. Due to early measures there was no severe infection, and the wound

Fig. 8. Normal adult dog. Open fracture of the radius with separation of the soft tissues from the periosteum. 14 days after fracture.

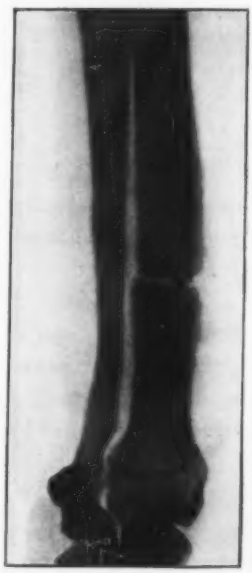

Fig. 9. The same as fig. 8. 21 days after fracture.

Fig. 10. The same as fig. 8. 28 days after fracture.

11. The same as fig 8. 42 days after fracture.

soon began to granulate. This granulation process led to earlier recovery of the periosteal blood supply on the medial aspect of the radius—the seat of the wound. As a result of this recovery of the periosteal blood supply we see already on the 14th day after the fracture (Fig. 8) a distinct cloud of callus on the medial aspect, while on the lateral there is no evidence of callus formation. Figs. 10 and 11, showing this same case 28 and 42 days after fracture, demonstrate well the known fact that a slight infection of bone, as we had here, acts to increase the production of bone, while a severe infection checks it entirely.

In the second series, where the soft tissues were separated from the periosteum of the radius at the point of entrance of the nutrient artery so that both the periosteal blood vessels and the nutrient artery were destroyed,

FIG. 12

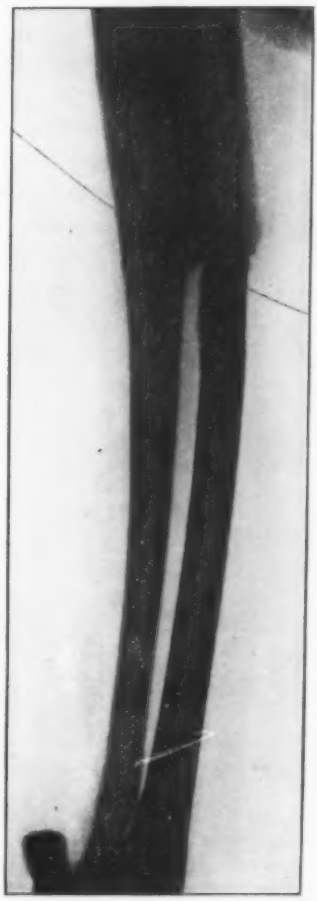

FIG. 13

Fig. 12. Normal adult dog. Open fracture of the radius with separation of the soft tissues from the periosteum and destruction of the nutrient artery. 21 days after fracture. The shot in the forearm was first revealed on X-ray examination.

Fig. 13. The same as fig. 12. 28 days after fracture.

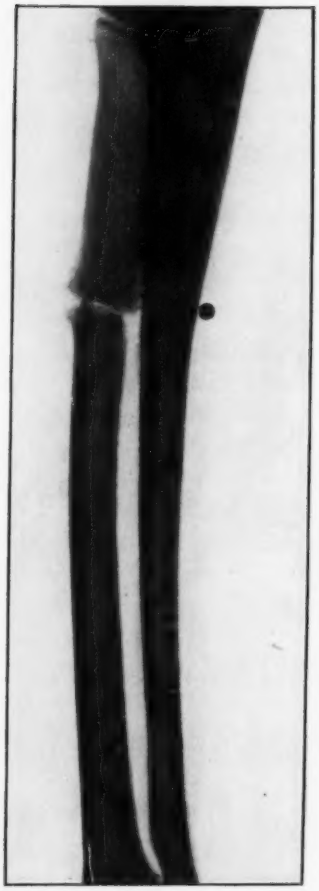

FIG. 14

FIG. 15

Fig. 14. The same as fig. 12. 42 days after fracture.

Fig. 15. Drawing from a specimen. Showing the relationship between the nutrient artery of the human tibia and the periosteal blood vessels.

we have very scanty callus formation and non-union (See Figs. 12, 13, and 14). What were the etiologic factors of this deficiency of callus formation? In other words, to which of the destroyed blood vessels, periosteal or intraossal, should we ascribe this result?

It would seem that the importance of the destruction of the intraossal vessels as etiology of non-union has been overestimated by nearly all writers, because it is evident that in the normal healing of all complete fractures there is always a destruction of the intraossal vessels. To recapitulate: in normal fractures the periosteum, when normally supplied with blood, soon begins to produce callus. The endosteum begins to form endosteal callus only after the intraossal circulation recovers, due to formation of an anastomo-

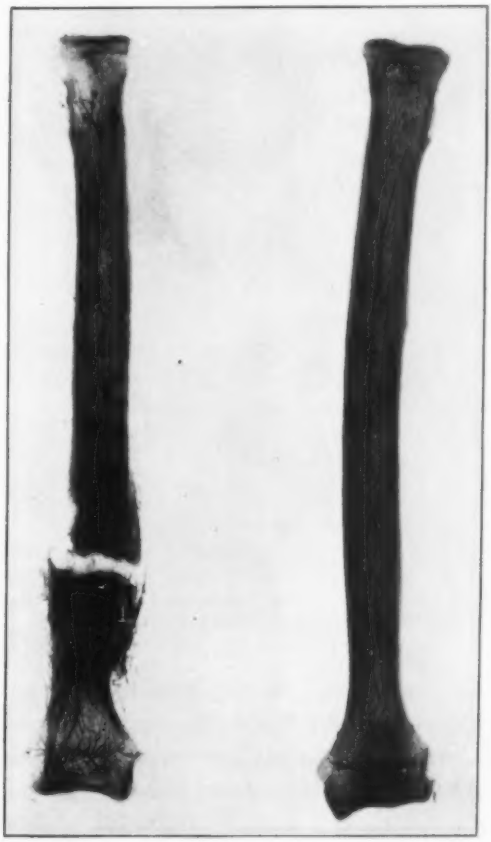

Fig. 16. Normal adult dog. Open fracture of the left radius with separation of the soft tissues from the periosteum. Blood vessels injected. 42 days after fracture. The normal right radius for comparison.

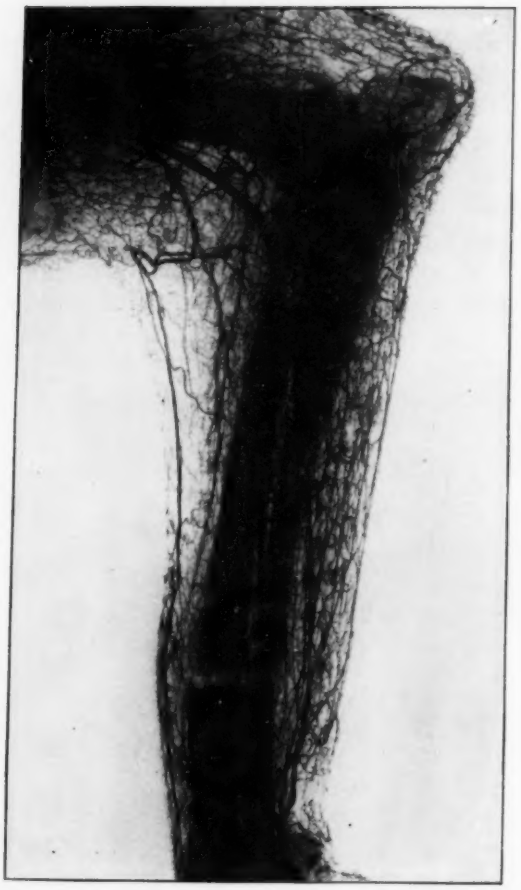

Fig. 17—a. Normal adult dog. Open fracture of the left radius with separation of the soft tissues from the periosteum. Blood vessels injected.

sis between the central portion of the torn branch of the nutrient artery and the metaphyseal net of vessels through the peripheral portion of the torn branch of the nutrient artery. In our experiments, where the nutrient artery was destroyed at its entrance into the bone, recovery of the intraossal circulation took place very slowly, only after formation of an anastomosis between the metaphyseal vessels of both ends of the bone. The separation of the soft tissues from the periosteum led to a marked impairment of the periosteal blood supply. The division of the nutrient artery completed the destruction

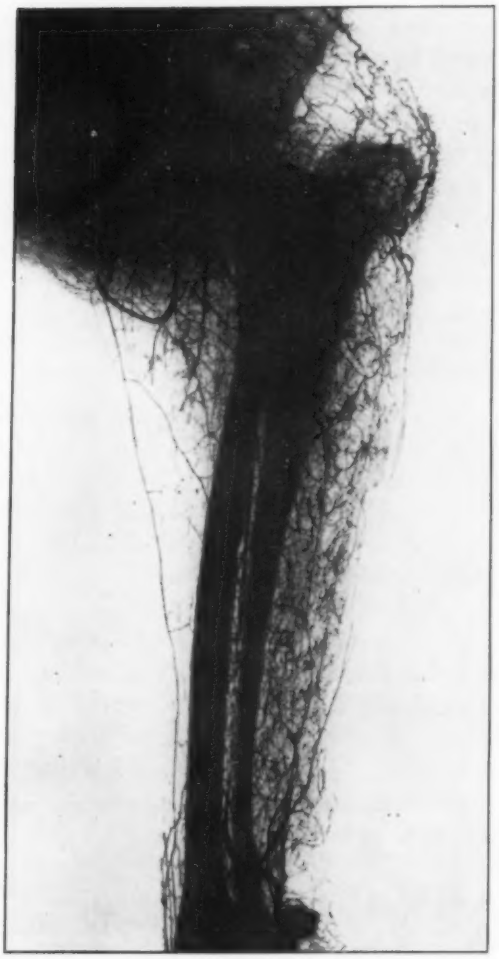

Fig. 17—b. The normal right forearm of the same dog for comparison. 42 days after fracture.

of the periosteal vessels in this area and increased the length of time necessary for the recovery of this circulation. But, before this slow recovery took place, the periosteum had passed from the stage of reactive stimulation into the normal stage of adult periosteum where osteogenic forces are latent. Because of this, when the periosteum finally recovered it was unable to produce callus. The endosteal callus could here have played a more or less useful rôle in the healing of the fracture if its blood vessels had not been destroyed and its

callus formation postponed for a very long period of time. We see from this that the destruction or ligation of the nutrient artery is important, in so far as the healing of fractures is concerned, only in cases where the periosteal blood vessels have been destroyed, and especially when the fracture is so located that the periosteum depends very largely for its blood supply upon the nutrient artery, as in our experiments of the second series. We are led to believe that this is also true in man. We have demonstrated from the study of the human tibia, which contains the largest nutrient artery of the human skeleton, that a limited area of the periosteum immediately about the entrance of the nutrient artery into the bone is dependent on that artery for its blood supply. A careful dissection of the leg, as shown in fig. 15, illustrates it very clearly.

Our experiments of both series prove that a destruction of the periosteal blood supply leads to non-union of fractures. That such a destruction is of frequent clinical occurrence is known to every one who has had the opportunity to observe a great many fractures associated with such crushing of the soft tissues as to separate them from the periosteum (leg run over by automobile; arm caught between belt and wheel, etc.) This, however, is not the only way in which the periosteal blood supply is destroyed. Rupture of the main vessels of the extremity by the bone fragments leads to hemorrhage and extensive thrombosis, and can bring about a disturbance of the periosteal circulation, which is sufficient to check, for a time, the callus formation, and so result in non-union. Further, contusion of the main vessel with rupture of the internal layer of the arterial tube, the external layer being intact, (a process which has been pointed out by H. Küttner*) also leads to thrombosis and to disturbances of the periosteal circulation.

We would like to touch briefly upon another point which we noticed during these experiments, viz., the changes of the blood vessels of the bone during the healing process. Healing of a fracture is always accompanied by an exuberant formation of the periosteal and intraossal blood vessels. This "fracture hyperæmia" in fractures of a forearm of an adult dog normally disappears about the 25th day after fracture. In our cases we still see the "fracture hyperæmia" after 42 days. Figs. 17a and 17b show a very pronounced new-growth of the blood vessels of the tissues about the fracture in comparison with the normal extremity. Fig. 16 shows the changes of the intraossal vessels, the branch of the nutrient artery, which supplied the

*Versammlung der Deutschen Gesellschaft für Chirurgie, 1921. Verhandlungen.

fractured portion of the bone having been replaced by a great number of anastomosing branches, while the branch in the uninjured portion of the bone has been markedly increased in size.

An analysis of the results of our experiments touches also upon an old disputed question—the supremacy of periosteal or endosteal callus. This question, which was solved at one time by the beautiful experiment of Ollier, has lately come into existence again. Lexer, who probably has done more work on regeneration of bone than anyone else, still holds that periosteal callus is far and incomparably more important than endosteal callus. On the other side, Bier's school claims supremacy for endosteal callus. Their basis for this contention is that grafted periosteum does not always give rise to new bone. The results of our experiments have convinced us that Lexer is right; the endosteal callus in our cases, of the first series, could not prevent pseudoarthrosis when periosteal callus formation was retarded. The claim that grafted periosteum does not always produce bone is unfounded because in the numerous experiments with periosteal grafts most authors did not distinguish between periosteum in stage of reactive stimulation for bone production and periosteum in the latent stage. Again, the age of the animal which supplied the periosteum for grafting was not taken into account. All these points are of the foremost importance. If we should express the difference between adult and young periosteum by an equation we would have: Periosteum of an adult animal plus reactive stimulation are equal to periosteum of a young animal. Reactive stimulations which are able to change the latent capacity for bone formation of the adult periosteum into an active stage are fractures, traumata, and slight infections of the bone.

CONCLUSION

1. An adequate blood supply of the periosteum is essential for normal union of fractures.

2. The periosteal callus plays a far greater rôle in union of fractures than the endosteal callus.

RELAXATION OF THE SHOULDER FOLLOWING BONY INJURY*

BY ROLAND HAMMOND, M. D., PROVIDENCE, R. I.

I wish to report three cases in which the capsule of the shoulder joint and the surrounding muscles have become greatly relaxed following fractures in this region. This condition was new to me until I discussed the subject with Dr. Frederic J. Cotton several months later and learned that he had recently written a paper upon the subject, which was published in the Boston Medical and Surgical Journal for October 6, 1921, Volume 185, page 405. I have encountered only those cases showing relaxation of the capsule and stretching of muscles with resultant subluxation and none of the cases of severer type in which a circumflex paralysis has been produced. The cases reported below are all fractures of the upper end of the humerus, in which the weight of the arm, swollen but not encumbered by apparatus, has produced a gradual exhaustion of the muscles of the shoulder, particularly the deltoid.

Case 1. The first case in which I observed this relaxation was in a fracture of the surgical neck of the right humerus with the fragments in good apposition. The fracture had been treated by a plaster swathe around the arm and chest, a triangular sling and some adhesive strapping over the shoulder. About ten days after the injury an x-ray examination was made to determine if the fragments were in good apposition before beginning manipulation. I was much surprised to note that the head of the humerus had dropped down and rested at the lower part of the glenoid. On examining the shoulder, I found that the head was actually lower than it had been when first seen following the accident and that a distinct groove or furrow was to be seen below the acromion. This relaxation could be easily overcome by lifting the arm upward so that quite a play in the joint capsule could be demonstrated. The shoulder could be moved up and down between one and two inches. At this time, I did not appreciate the significance of this relaxation and continued the treatment as outlined above. The shoulder recovered function well, and at the end of a month motion to a right angle was present. Ten days later, motions had recovered nearly to normal and weakness only remained.

This patient was seen one year after the accident. No relaxation of the

*Read before the Boston Orthopaedic Club, February 26, 1923.

shoulder could be demonstrated either clinically or by x-ray. All motions were present except that abduction lacked about ten degrees of normal. All other motions were normal and the strength of the arm had completely returned.

Case 2. The next case was seen in consultation about the same time and was a fracture of the surgical neck of the right humerus. There was considerable swelling and ecchymosis about the shoulder, and x-ray examination showed the fragments in good apposition, but with so much subluxation of

Fig. 1. Case 1. Fracture of surgical neck of right humerus, taken a few hours after the accident.

the head that I feared there was a possible dislocation of the humerus downward. Accordingly, I gave the patient some gas oxygen and demonstrated that no dislocation was present. In this case, under anesthesia the humerus could be readily moved up and down to a distance of about two inches. The shoulder was tightly bound so as to overcome any further tendency to subluxation and the patient passed out of my observation. I did not see her for a year, when she returned at my request. Examination showed a normal shoulder except for some irregularity of outline of the bone at the site of

Fig. 2. Case I. Fracture of surgical neck of right humerus, taken ten days after accident, showing dropping of humerus from relaxation of shoulder.

fracture, but all motions were normal and the function of the joint had been completely restored.

Case 3. The third case was seen in consultation two weeks later with a fracture of the anatomical neck and also of the greater tuberosity of the left humerus. This injury had been received five weeks before and an x-ray examination at that time had been reported as showing the humerus in good position and the fragments in fairly good apposition. An x-ray examination five weeks after the accident had been reported as showing a dislocation of

Fig. 3. Case I. Fracture of surgical neck of right humerus, taken one year after accident, showing position of head in socket partially restored.

the humerus downwards. I was asked to see the case from the clinical aspect. Examination showed the head of the humerus apparently in its normal position in the glenoid cavity. All motions were limited, but could be carried out to a degree inconsistent with a true dislocation. There was no furrow nor sagging of the head which had been demonstrated in the other two cases. I made x-ray examinations both in the sitting and recumbent postures and found that the humerus was apparently dislocated downwards. There was, however, a small fragment of bone apparently displaced upwards from the

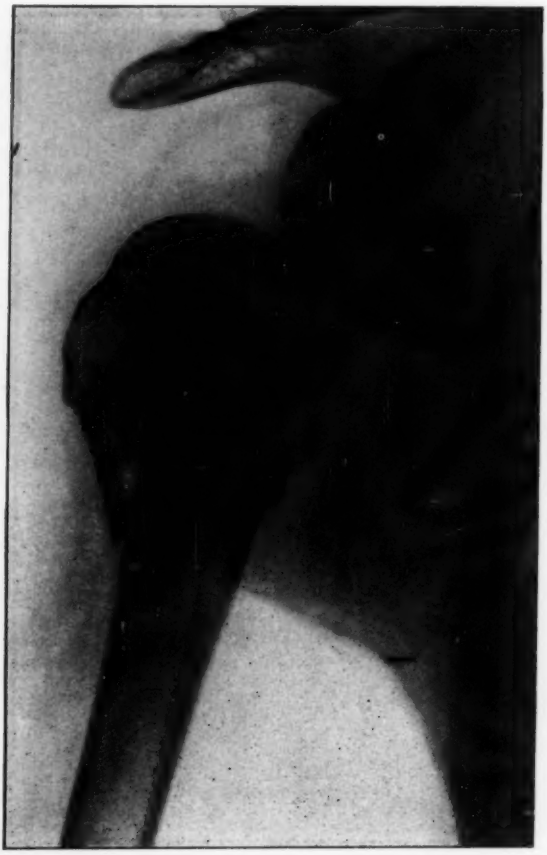

Fig. 4. Case II. Fracture of surgical neck of right humerus, taken two weeks after accident, showing subluxation of humerus.

head, which still remained in the joint cavity. With the clinical picture of a shoulder not dislocated and with the x-ray examination showing a small fragment of the head still remaining in the socket, I gave the opinion that no dislocation was present.

I did not see the patient again for one year. Examination showed the head in the same position in which I had found it one year before. There was considerable limitation of motion. Abduction and elevation could be carried out to nearly normal limits. Forward movements were practically normal,

Fig. 5. Case II. Fracture of surgical neck of right humerus, taken during anesthesia, showing how the relaxation could be relieved by forcing the humerus upward.

but backward motion was so limited that the patient could not put the arm behind the body but only to the side of the hip. X-ray examination showed no change in the position of the bone from that found one year before.

These three cases have demonstrated that subluxation of the shoulder may exist without giving rise to symptoms and without apparent pressure on a nerve.

X-ray examination in the case of shoulder injuries may be a hindrance instead of a help unless the findings are checked up by a careful clinical examination.

Fig. 6. Case II. Fracture of surgical neck of right humerus, taken one year after accident, showing normal position of head in socket.

It is well known that the angle at which x-ray examinations of the shoulder are made will show the head in varying relation with the glenoid and the acromion, but never, so far as I am aware, to the extreme degree seen in these films.

Stereoscopic views may be of value in these cases. I wish to forestall criticism for not presenting stereoscopic films in these cases by stating that they were purposely omitted. In the third case, the diagnosis of dislocation was made by a roentgenologist of wide experience on a flat plate, and I felt

Fig. 7. Case III. Fracture of anatomical neck and greater tuberosity of left humerus, taken five weeks after accident, showing subluxation of head of humerus.

that it would be better to carry out the examination in the other cases with flat plates and attempt to correlate the clinical and x-ray findings along these lines.

The subluxation, when of mild degree, takes care of itself and the shoulder recovers its normal function in the usual length of time.

With this tendency to relaxation of the capsule and resultant subluxation in mind, we should remember the possibility that this condition may follow any shoulder injury. It would seem to me that there is a possible danger in applying heavy apparatus to an arm to secure traction in a fracture of the shoulder joint, whether the traction be applied in bed or whether it be ambulatory.

Fig. 8. Case III. Fracture of anatomical neck and greater tuberosity of left humerus, taken one year later, showing subluxation persisting.

TREATMENT OF BONE AND JOINT TUBERCULOSIS WITH TUBERCULIN AND HELIOTHERAPY.

WILLIAM ARTHUR CLARK, A.M., M.D., PASADENA, CALIFORNIA

In the last fifteen years there has been a tendency toward operative interference in tuberculosis of the bones and joints, due perhaps to the general trend of orthopaedic surgery during this time. The present trend may be considered as a wave which may have its recession but which will undoubtedly leave some well established methods.

It is the purpose of this study to emphasize the conservative and hygienic treatment without seeking in any way to detract from the importance of rational operative procedures. Although pulmonary tuberculosis has been treated by open air and sunshine methods for many years, we have more or less neglected these measures in the care of bone and joint tuberculosis.

Any effort which we may put forth in treatment must be regarded as an aid to nature, for it can not be said that the surgeon has a specific cure. He can only promote healing and preclude deformity. The healing process is an encapsulation by fibrosis, just as in pulmonary tuberculosis. There is a lack of accord among orthopaedic surgeons on many important methods, not to say principles. Part of this is due to interpretation of results in groups of cases, some of which may not have been tubercular. Prior to 1914, when we began to diagnose Legg-Perthes disease of the hip, all these cases were called tuberculosis and their incorporation in statistics renders conclusions as to averages unreliable.

Rest, heliotherapy, tuberculin and general hygiene are the methods of most importance in children.

TUBERCULIN.

Tuberculin has had its ups and downs perhaps more than any other one method of treatment. Its sponsors are in many instances no less radical than its condemners. It would appear that variations in results arise largely from variations in methods of administration. Waterhouse[1] who has a "profound faith" in it, uses Koch's New Tuberculin (TR) and begins every case with the minimum dose of 1/20000 milligram subcutaneously. He gives it once a week increasing the dose according to the following table:

1st	week	1/20000	mg.
2nd	"	1/15000	"
3rd	"	1/12000	"
4th	"	1/8000	"
5th	"	1/6000	"
6th	"	1/4000	"
7th	"	1/3200	"
8th	"	1/2400	"
9th	"	1/1800	"
10th	"	1/1500	"
11th	"	1/1200	"
12th	"	1/1000	"

If one dose causes marked reaction the next dose is not increased. The maximum dose is usually 1/1000 mg. He sometimes gives 1/250 mg., but never ventures beyond this.

Although tuberculin is practically harmless to a healthy person, it is a most powerful poison to a tubercular patient. Twinch[2] from an extensive experience, concludes that it is the "only known reliable remedy" for mesenteric and bronchial gland tuberculosis, which he regards as practically always the primary focus for tubercular joints. He reports 68% recoveries with it as against 34% without it. The average duration of cases which recovered under tuberculin was 11½ months, while cases without it averaged 5½ years. He regards it not as an extraneous protective but as a stimulant which causes the organism to make its own protective substance. Adequate time is required for this, so haste has no place in treatment with tuberculin. If temperature goes up one degree in second twelve hours, the dose is reduced after stopping entirely for one week. A positive reactionary phase must be maintained at a high level. A persistent or severe negative phase may be removed by hypodermic use of a nuclein, e.g., sodium tritico-nucleinate (0.001 once a week). He suggests that one of the favorable effects of tuberculin is the stimulation of leukocytosis which counteracts the leukopenia usually present in tuberculosis.

Pottenger[3] states that in 1905 he found a fourth of the institutions in Germany were using tuberculin, while on another visit in 1909 he noticed that it was being used in two thirds of them. His reports have to do mostly with pulmonary tuberculosis.

Kleinberg[4] comes out strongly against it. He reports thirteen cases extending over a period of two years and "can not recall a single case of out-and-out success." In only one case was there any improvement and, even in that, entire credit can not be given to tuberculin because autogenous vaccine was also used, Over confidence in it and improper dosage may result in exacerbations or even fatalities.

His results, however, are vigorously refuted by others, notably Landman[5] and Mayer[6]. The latter reports two cases of striking success and suggests that poor results may follow difficulties in administration. Landman refers to the files of Bonime's Polyclinic Tuberculin Dispensary for records of many cases in which good results were obtained. The conception of a cure at that dispensary includes complete tuberculin immunity, healing of blind pouches and sinuses, absence of recurrence over a period of two years during which the patient reports for observation every three months.

Bonime[7] observes the following principles: (1) A tolerance must be gained to the tuberculin to which the patient is hypersensitive. (2) A maximum immune response must be produced at each inoculation. (3) To get complete tolerance we must increase the dose each time sufficiently to offset the tolerance gained by the previous dose. (4) A constitutional reaction should occur at long intervals to give clue to dosage. (5) This reaction loses for the patient a certain amount of gained tolerance and increases his sensitiveness temporarily. A decrease in the next dose is required. (6) A local reaction does not call for decrease in the next dose.

Reliance can not be placed entirely on tuberculin as a specific, no more than on any other one method of treatment. It must be combined with rational hygienic treatment. Its administration to a patient confined to bed with a cast on in a more or less closed room, will give a result different from that obtained with the same dosage and same patient kept out in the open sunshine without casts. Individual variations in resistance and difference in hygienic environment are additonal factors to be taken into consideration in interpretation of results.

Before beginning the administration of tuberculin I make a Detré differential test to determine the specific susceptibility of the patient. The tuberculin to which the patient is most sensitive is then chosen for administration. The concentrated form is then diluted with normal salt solution to such a strength that the initial dose will require only about one-tenth cubic centimeter of the dilution. Two dilutions are usually sufficient to secure the proper strength.

For the cases reported here the bouillon filtrate (B.F.) was used, since all the patients reacted more sharply to this form than any of the others in the Detré test. The beginning dose was 1/20000 mg. injected subcutaneously. It will be noticed that the increase in dosage was practically the same for each case. This was due to the fact that there was practically no difference in their reaction to the tuberculin. The maximum dose of 0.01 mg. was reached after about three months' treatment. In the beginning the doses were given once a week and after a month increased in frequency

to twice a week. No constitutional reaction occurred which could be definitely attributed to the tuberculin. Although there was a rise in temperature in the first twelve hours following the dose in several instances, a similar rise was sometimes noticed with no relation to the time of the dose.

Two of these cases had secondary infections due to persistent sinuses, but they were not given vaccines because it was the aim to try the effect of tuberculin alone. Blood counts were made before beginning treatment and again after three months. The general appearance of the patient and of the sinuses were taken as additional criteria of effect of the tuberculin. The temperature charts (impracticable to reproduce here because of their length) were kept with records twice a day and every four hours for the first twenty-four hours following each injection.

No change was made in any other treatment when the course of tuberculin was begun. The children kept their same places on the sun porch and received their heliotherapy the same as usual.

Case 1. C. J. Girl, age 11. Tubercular spine. The disease began when she was about a year old and is said to have followed an injury in which her spine was thought to have been broken.

Admitted to Los Angeles County Hospital in July, 1919. Previous to this (date uncertain) she had had a spinal graft (Albee) operation, following which two sinuses appeared as described below.

Condition in September, 1922: General condition and nourishment good. Moderate kyphosis in upper lumbar region. Two sinuses, one about 20 cm. to right and the other about 20 cm. to left of the kyphosis. Abundant sero-purulent discharge from the one on the right, moderate amount from the left, requiring daily dressing.

Roentgenogram shows destructive process involving the third and fourth lumbar, the third almost totally destroyed.

Blood count: Hb. 35%. Reds 2,860,000. Whites 5200.

Detré differential tuberculin reaction: 0—0—4—0—0. 36 hours.

Patient on Bradford frame usually in ventral position with chest and shoulders supported producing hyperextension of the spine (Rollier position). Heliotherapy averaging about three hours daily.

Tuberculin, B. F., first dose October 2, 1922, 1/20000 mg., subcutaneous; once a week until October 30, then twice a week. Dosage gradually increased until January 4, when she was getting 0.01 mg., which was continued until January 15. No constitutional reaction. Local reaction six times.

SUMMARY OF TEMPERATURE CHART:

	99 to 100	100 to 101	101 to 102	102 to 103	103 or over
July	31 times	17 times	once		
August	34 "	19 "	4 times		
September	29 "	17 "	7 "	once	once
October	20 "	6 "			
November	24 "	6 "			
December	25 "	9 "			

The temperature was lower and more regular during the course of tuberculin. Conditions after 3½ months treatment: General condition appears about the same. No change noticeable in sinuses. Blood count: Leucocytes 7500.

Case 2. M.S. Boy, age 9. Tubercular spine. Nothing of significance in the family history. Had an abscess in the right groin for six years. This healed about a year ago but another one appeared in the left groin soon after.

Figure 1. Case 2. Tuberculosis of spine with complete destruction of I, II, and III L.

General condition (September, 1922) rather poor, pale and undernourished. Phlyctenular keratitis left eye. Tonsils small but cystic. Cervical glands small and soft. Chest: Tendency toward emphysematous shape due to kyphosis. Lungs: Scattered crepitant râles, increased whisper over right apex. Heart normal. Reflexes normal.

Moderate kyphosis upper lumbar. Five sinuses discharging sero-purulent material: one in lumbar region, one left inguinal, two in right gluteal region, one on posterior aspect of right thigh, upper third.

Roentgenogram (Figure 1) shows complete destruction of I, II and III L; partial destruction of XII D and IV L. Proliferation slight. Hips normal. Lungs: no conclusive evidence of tuberculosis.

Blood count: Hb. 55%. Reds, 3,880,000. Whites 11,200.

Urine analysis: Tr. albumen.

Cultures from sinuses gave growth of staphylococcus albus, hemolytic streptococcus and B. proteus vulgaris.

Detré reaction: 1—0—3—0—0.

Recumbent on Bradford frame since August, 1921; ventral and dorsal position alternately. Sinuses require daily dressing. Taylor tidal irrigation tried on two of them without permanent improvement. Heliotherapy about three hours daily.

Tuberculin, B. F. begun September 23 with 1/20000 mg. Given once a week until October 30, then twice a week. Dose gradually increased to 0.01 mg. beginning January 4 and kept at this amount until January 15. No general reaction. Local reaction three times.

	99 to 100	100 to 101	101 or over
July	22 times	10 times	
August	46 "	29 "	15 times
September	30 "	10 "	twice
October	19 "	8 "	
November	10 "	3 "	twice
December	22 "	9 "	3 times

Condition after 3½ months treatment: General condition improved; color better and face fuller. No appreciable change in sinuses. Blood count: Leucocytes 23000.

Case 3. R.A. Girl, age 7. Tubercular hip. Pain in right hip began in May, 1921. Admitted in May, 1922. Family history negative for tuberculosis.

Condition on admission: Eyes, mouth, throat, lungs and heart negative. Abdomen protruberant. Right hip flexed and adducted, painful and tender. Two small sinuses, one near the labia and one on outer side of upper right thigh. Discharge slight. Angle of adduction deformity 160 degrees.

Flexion deformity corrected by extension, but adduction persists. Roentgenogram shows advanced destruction of right acetabulum and of head and neck of femur (Figure 2). Marked destruction of XII D vertebra and partial destruction of XI D and I L.

Blood count: Hb. 65%. Reds 3,120,000. Whites 12,000.

Detré reaction: 3—0—4—0—0, 36 hours.

Patient has been kept in dorsal recumbent position on Bradford frame with extension and spica casts alternately on right leg. Heliotherapy averaging about three hours daily.

Tuberculin, B.F. injections begun September 30, 1922, 1/20000 mg. once a week for four weeks then twice a week. Dose increased gradually up to 0.01 mg.

Figure 2. Case 3. Advanced tuberculosis of right hip with adduction deformity.

	99 to 100	100 to 101	101 to 102	102 to 103	103 or over
July	5 times				
August	3 "				
September	14 times	4 times	twice		once
October	7 "				
November	10 "	3 "			
December	8 "	once			

Condition after 3½ months' treatment: No appreciable change in general condition. Sinuses are discharging much less than before treatment.

Blood count: Leucocytes 12,000.

Only cases with sinuses were selected for tuberculin treatment.

In Case 1, the temperature chart showed a striking regularity at a comparatively low level under tuberculin.

In Cases 2 and 3 the curve was also lower and more regular during the course of tuberculin, but not so noticeably so as in Case 1.

HELIOTHERAPY

Treatment of human ills by the sun's rays is not a new idea. It is said to have been used in the time of Hippocrates. The method is empirical, although theories regarding the therapeutically active part of the solar spectrum have been generally accepted. It is possible that the effect of roentgen rays, of artificial ultra-violet light and of direct sunlight may be due to the same order of vibration. The sun furnishes (1) actinic or chemical rays (wave length less than 0.39 microns), (2) light or visible rays (length 0.39 to 0.8 microns) and (3) heat rays (length 0.8 to 20 microns). All these rays are capable of being transformed into heat.

The rate of vibration varies inversely with the wave length. Thus, the visible or light rays vibrate at 430 trillion (wave length 0.8 microns) to 750 trillion (0.39 microns) per second. The earth's atmosphere transmits rays a little higher in frequency than this 750 trillion but there comes a point in the spectrum, at 0.29 microns wave length, above which transmission is not possible. The atmosphere is opaque to these rays. There is quite an appreciable difference in transparency of substances which we are accustomed to consider equally transparent. For example, ordinary glass transmits only those rays whose wave lengths are between 0.35 microns and 2.5 microns. It is, therefore, opaque to most of the ultra-violet and infra-red rays. The following table shows the relative transparency of various substances:

LENGTH OF WAVES TRANSMITTED

Glass	0.35	to	2.5 microns
Quartz	0.20	to	4.0 microns
Fluorite	ultra-violet	to	7.0 microns
Rock salt	ultra-violet	to	17.0 microns

Since ordinary glass is opaque to the rays of short wave length it is readily seen that heliotherapy can not be effectively carried out in glass enclosures or where the sun's rays pass through windows.

Pigmentation is a criterion of therapeutic effect. Patients who do not tan well do not derive as much benefit from heliotherapy as those who do. Blondes do not tan as well as those of darker complexion. Campbell says that negroes take on this pigmentation to such an extent that even the blackest of them can be made a shade blacker. On my visit to Rollier's hospitals at Leysin in 1916, I was surprised at the deep tan which he was getting on his patients. The skin resembled a well browned bread crust and seemed tough and resistant. I have never seen so deep a tan anywhere, even on the life guards at the beaches. Whether or not the rays penetrate actually to the joint does not seem to matter since the uniform pigmentation of the entire skin produces the desired result.

The local application of the rays is a method of necessity rather than choice but has a beneficial effect, nevertheless, on open tuberculosis and other chronic sinuses. One effective method of giving local heliotherapy is by means of the Thezac-Porsmeur lens. This is a 12-inch double convex lens with 72-inch focal distance. The effect is that of a burning glass and it is possible that the results are due more to a baking process than to the actinic rays which are mostly cut off by the glass. The lens is used at such a distance from the skin that the circle of light is from three to five inches in diameter. The method originated at Porsmeur in France and has been used by Lovett[8] from whose paper these details were obtained. Treatments are given beginning with five minutes a day, gradually increasing up to about half an hour. He reports marked improvement in a tubercular hip with sinuses, but unsatisfactory results in two cases of Pott's diesease with abscesses. Very pronounced improvement occurred in several cases of chronic non-tubercular bone diseases.

General heliotherapy, as introduced by Rollier, is the method of choice. Some difference of opinion persists regarding the most favorable locations for giving this treatment. Perhaps, as Lucas suggests, these opinions are influenced by the residence of the observer. Those who have institutions at the sea level claim that the best results are obtained there, while those who give the treatment at high altitudes claim that as the most favorable place. Data furnished me by the Mount Wilson Solar Observatory show a marked difference in atmospheric transmission between sea level and high elevations. This difference is greater for the shorter wave lengths than for the longer ones. It is also greater when the sun is inclined than it is at the noon

meridian. For instance, taking the wave length 0.4 micron in the following table, 73.8% of these waves are transmitted to Mt. Wilson and 53.5% to Washington at noon. When the sun is inclined 60 degrees, however, 53% are transmitted to Mt. Wilson and only 28.6% to Washington. In the former case the Washington (practically sea level) transmission is over ⅔ that of Mt. Wilson while in the latter case it is only a little more than one-half.

COMPARATIVE ATMOSPHERIC TRANSMISSION:

	Wave length	0.3 micron	0.4 micron	0.5 micron	0.6 micron	0.7 micron
		ZENITH DISTANCE 0°				
Mt. Whitney	14,500 ft.	50%	78.7%	90.3%	92.3%	95.4%
Mt. Wilson	5,500 ft.	31	73.8	87.3	89.6	95.2
Washington	Sea level	?	53.5	70.4	75.9	83.8
		ZENITH DISTANCE 60°				
Mt. Whitney		25%	61.9%	81.5%	85.2%	91.0%
Mt. Wilson		?	53.0	76.2	80.3	90.6
Washington		?	28.6	49.6	57.6	70.2

Since there is a much higher percentage of the various rays, especially the therapeutically active rays of short wave length, transmitted at high elevations than at the sea level it would naturally follow that the former locations are best. Furthermore, the longer wave lengths which produce the burning and depressing effects due to heat are not increased with high altitudes in the same proportion as the actinic rays.

With the idea of comparing the chemical effect of the sun's rays at different altitudes, and at the same time testing the amount of penetration, if any, through living tissues, I did a series of experiments with photographic paper. These experiments were all done within a period of three weeks in September so that variation due to seasonal height of the sun could not enter as a factor. Variations in atmospheric conditions due to moisture or other sources of haziness were practically eliminated because at this season of the year in southern California there is no appreciable difference in the sun's power from day to day. The old style solio printing-out paper was used in order to avoid variations in development which would occur with the bromide papers now in general use.

Exposures were made on Mount Wilson, elevation 5,500 feet, on the beach, and at an intermediate level of about 1,000 feet. All experiments were done as near noon as possible. Some were made as late as 2.30 but in comparing results, only those exposures made within a half hour of the same time of day were compared.

The exposed papers, after fixing, were measured on a scale. This scale

was made by exposing the same kind of paper on which the experiments were made for definitely timed periods of 5, 10, 15, 20 seconds, etc., up to 105 seconds and the 21 shades thus obtained were labeled 5 to 105 each one 5 points from the preceding one. These papers were then pasted on a card and a hole punched through the center of each. A graded scale analogous to the familiar hemoglobin scale was thus obtained.

Comparing the exposures made on Coronado Beach with those made on Mount Wilson it was found that there was a slight difference in the shade of the papers exposed for five seconds at the same time of day. The Mount Wilson exposures corresponded to shade 15 on the scale and the beach exposures to 10, the former one shade darker than the latter. For the longer exposure periods, however (10 to 60 seconds), there was no appreciable difference. No difference could be noticed between the Coronado and Pasadena exposures of any periods.

To test the penetration of rays through living tissue the palm of the hand was placed over the printing frame in such a way that any light which struck the paper would have to pass through the hand. At Coronado an exposure of 5 minutes through the hand produced no effect on the paper. Exposures of 15 minutes and 30 minutes produced a barely preceptible darkening, not enough to measure on the scale. The Pasadena exposures of 5 minutes through the hand gave a very slight darkening and those of 15 minutes produced a shade a trifle lighter than 5 on the scale. Exposures on Mount Wilson through the hand gave distinctly darker shades than those of Coronado or Pasadena. The 15 minute exposure was slightly lighter than 10 on the scale and the 30 minute exposure corresponded fully to 10. For finer comparison the short exposures were best. The exposures of 60 seconds were so dark that readings on the scale were not as easy as those of 5 to 30 seconds. One interesting observation was that a difference in time of day easily cancels any difference that may be due to altitude. For instance, at noon exposure on the beach of 60 seconds gave shades corresponding to 95 and 100 on the scale, while exposures at 2.30 on Mount Wilson corresponded to 75.

Further experiments along this line are necessary before drawing broad conclusions, but the foregoing results show that there is greater penetrating power at the higher elevations. This penetration may be due to the greater abundance of high frequency rays at higher altitudes.

That light has a destructive effect on the tubercle bacillus is a fact well known to bacteriologists. According to McFarland[9], the organism does not develop well in the light and when its virulence is to be maintained the culture must always be kept in the dark. Direct sunlight kills it in from

a few minutes to several hours depending on the thickness of the mass of bacteria exposed. Park and Williams[10] found that sputum containing the organisms when expectorated on the sidewalk in direct sunlight is sterilized by the time it is dried sufficiently to be blown away in the dust. Moody[11] says that cultures do not grow well under the electric light of an incubator but do better when shaded. He also states that guinea pigs injected with tubercle bacilli are not effected by the organism if they are allowed to run in direct sunlight. For diagnostic purposes they must be kept in the dark after being injected.

Studies by Sellards[12], of the Harvard School of Tropical Medicine, on the photodynamic action of sunlight furnish some interesting suggestions regarding the nature of heliotherapy. He found that with the aid of certain fluorescent substances such as eosin, acredin and chorophyl the sun's rays may become surprisingly active, approaching in abiotic properties the magnitude of roentgen rays or similar short wave lengths. For example, red blood corpuscles are unaffected by eosin solution in total darkness but are hemolyzed if exposed to sunlight even in dilute solution. He suggests that since malaria parasites are retarded in growth by blue light, the specific action of quinine (a fluorescent substance) may be due to its fluorescent properties in changing ultra-violet rays to blue radiations. Paramecia were killed in six minutes by a 1-20000 solution of acredin in direct sunlight but remained alive indefinitely in total darkness.

I can well remember my experiments in elementary bacteriology in which typhoid bacilli were killed by direct sunlight in five minutes.

All these observations lead one to believe that the benefit derived from heliotherapy is dependent upon the power of the sun's rays to destroy pathogenic organisms and at the same time stimulate the patient's protective powers.

Aside from speculation as to its nature, the practical results obtained by sun-treatment as demonstrated by Rollier, Calvé and an increasing number of clinicians and orthopaedic surgeons in America leave no doubt that its use is not only justified but definitely indicated in bone and joint tuberculosis in all forms and stages.

For its practical application I use the following schedule which is made up after the Rollier method with slight modifications:

	Part exposed	Time exposed	Number of periods
First day:	feet	5 min.	4
Second day:	feet	10	4
	legs	5	
Third day:	feet	15	4
	legs	10	
	thighs	5	

Fourth day:	feet	20	4
	legs	15	
	thighs	10	
	abdomen, fore arms and hands	5	
Fifth day:	feet	25	4
	legs	20	
	thighs	15	
	abdomen, fore arms and hands	10	
	chest, upper arms and shoulders	5	

The length of each exposure period is increased 5 minutes each day up to one hour. The patient will then be getting a total of four hours a day in the sun. The face is never covered but is always shaded by a hat. Sinuses are freely exposed by removing all dressings.

This schedule should be enforced not rigidly but with good judgment. In the beginning, every precaution should be taken to avoid exhaustion, depression, sunburn and exacerbation of the local lesion or general symptoms. Temperature should be carefully watched, also the effect on the blood counts. Another procedure which may yield valuable data is the determination of the basic metabolic rate before treatment is begun and after it is well under way. So far as I know, this has not been done. The hibernation habits of some animals suggest that metabolism is at its lowest ebb in total darkness and probably at its highest in direct sunlight, other conditions being equal. Studies along this line will help to put heliotherapy on a more scientific basis.

Many detailed reports of results are now available to show that the course of so-called surgical tuberculosis is materially shortened and operative intervention avoided by this method. Freiberg[13] reports: (1) a tubercular hip of three years' duration with ten sinuses showed general improvement and all sinuses closed after three months' exposure; (2) a Pott's disease of four years' standing with two sinuses which closed in four months; (3) a tubercular hip with excision of femoral head and profuse suppuration cured in eight months. Campbell's[14] statistics based on 65 cases show cures in 28 cases, 18 of which were exposed from six to nine months and none of which had to be treated more than two years. These cases remained apparently cured for from one to five years. Rollier's[15] earlier records (1129 cases) show cures in 87% of closed cases and 76% of open cases. Of 158 tubercular hips 125 were cured, of which 102 "regained complete recovery of articular function." For comparison let us note the percentages compiled by Humphries and Durham[16] from cases treated at the New York Ortho-

pedic Hospital prior to 1917. Average duration of treatment for tubercular ankles 4½ years, knee 7 years, hip 7½ years, spine 7½ years.

In my experience, cases undoubtedly do better under heliotherapy in many ways which can not be measured as well as in ways that can. The following cases, as well as the above three, have been receiving heliotherapy under my care for periods varying from six months to two years:

Case 4. H. J. Girl of 6. Tuberculosis of right hip. Mother has pulmonary tuberculosis. Only child. Always well until present trouble. Began to limp in right leg in August, 1919, when four years old. Did not complain of pain either on walking or at night in the hip but mentioned slight pain in right knee which did not interfere with walking.

Condition in February, 1921, when first seen by me: General appearance good; well nourished but color poor. Temperature 99. No glandular enlargement. Throat normal. Lungs and heart show nothing abnormal. Abdomen negative. Walks with a decided limp on the right, throwing trunk and pelvis forward when weight comes on that side. Slight muscular atrophy of right leg and thigh. Right leg 45.5 cm., left 47. cm. Motion in right hip limited as follows: extension to 140 degrees, flexion to 90 degrees, abduction to 165 degrees, internal rotation to 80 degrees, external rotation to 95 degrees[17]. No tenderness on palpation or manipulation of the hip. Von Pirquet test negative.

Roentgenogram shows flattening of head of right femur without roughening or other signs of destruction.

Because of the mild symptoms, the negative Von Pirquet and roentgenologic findings and sharp limitation of external rotation, this case was at first regarded as osteochondritis. Extension was applied until flexion deformity was corrected, then a spica cast.

June 25, 1921. Cast removed about six weeks ago. No subjective symptoms since then. Slight muscle spasm. Flexion to 130 degrees, extension to 170. On crutches without weight bearing.

July 29. Injured right hip a few days ago in a fall. Since then she has complained of pain and tenderness. Marked muscle spasm. Put to bed with extension.

August 27. Temperature 99.6. Fullness and tenderness in front of right hip. Von Pirquet positive. Heliotherapy was started a few weeks ago. Roentgenogram showed signs of destruction in the joint. The whole picture was now one of a tubercular hip.

Following the extension, the hip was immobilized in spica cast which, after three months, was replaced by a Thomas brace. The patient tanned well

under sun treatment, being in a favorable location, the foot hills of the Sierra Madre mountains.

The fullness first noticed in August, 1921, became gradually diffuse and fluctuant, evidently an abscess which never broke.

Condition February, 1923: Full color in face and good tan over entire body; robust and healthy. Right hip flexion to 145 degrees, extension to 180, abduction to 160, internal rotation to 70, external to 120. The abscess has subsided so that measurements of the upper thighs at corresponding levels are equal. Slight adductor spasm, slight pain on forced flexion and abduction. Brace and crutches continued for protection.

Although this case is not yet cured the condition is most favorable. It is possible that the tubercular process supervened on the osteochondritis following her fall, since there was a marked change for the worse in the clinical symptoms and roengenographic findings after that.

Case 5. K. J. Boy of 4. Tubercular spine. Seemed perfectly well

Figure 3. Case 5. Beginning caries of XII D and I L.

until about three weeks before admission to hospital in January, 1922, when pain in back began. Roentgenogram (Figure 3) at this time showed narrowing of XII D and I L and of the intervertebral space between them.

Condition in July, 1922. On Bradford frame, ventral (Rollier) and dorsal position alternately. General appearance healthy but rather pale. Very slight kyphosis over XII D but no tenderness. Physical examination otherwise negative.

Had been getting heliotherapy since January, 1922, and this treatment was intensified during the six months beginning July, 1922.

Condition January, 1923. Color is better but tan not as deep as desired. General condition improved. Roentgenogram (Figure 4) shows partial fusion of XII D and I L producing a wedge-shaped mass about the size of one normal vertebra. The bones are more dense than a year ago and the process does not seem to be active. At any rate, it has not spread beyond the original focus. This collapse of these two vertebrae is interesting in view of the fact that the patient was recumbent constantly during the time it occurred.

Figure 4. Case 5. Taken a year later than figure 3, showing collapsed vertebrae.

Case 6. M.A. Girl of 4. Tubercular left hip. Father has tuberculosis. A Mexican child from whom history could not be obtained. Roentgenogram taken in May, 1922, showed advanced destruction of acetabulum and head of femur. It has been necessary to keep the hip in spica casts most of the time to prevent adduction but heliotherapy has been carried on as much as possible beginning in July, 1922. Roentgenogram taken December, 1922, showed apparent ankylosis of the hip in slight abduction, the neck in moderate valgus. Practically no motion or tenderness in the hip.

Case 7. J.W. Boy of 11. Tubercular spine with paraplegia. Admitted in October, 1922. For the past five months has had complete paralysis of both legs with loss of sensation from epigastrium down; loss of sphincter

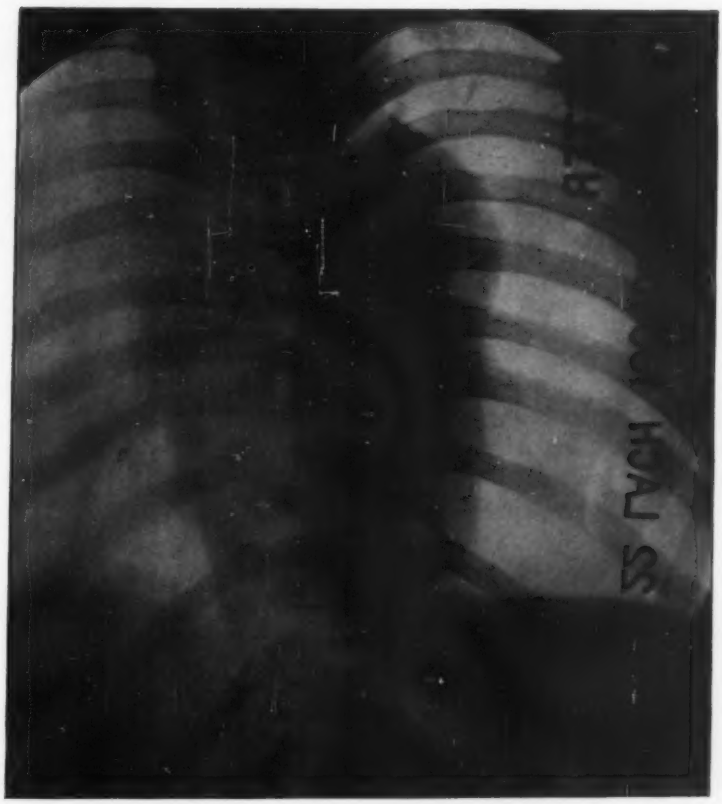

Figure 5. Case 7. Tubercular spine with paraplegia showing abscess pocket which was aspirated through intercostal space.

control. Had an ankylosing operation (Hibbs) in August, 1922, at another hospital.

Condition on admission: Motor and sensory paralysis below level of umbilicus, including bladder and rectal sphincters. Kyphosis from VI D to IX D with discharging sinus about 5 cm. to the left at about the level of VIII D. Roentgenogram (Figure 5) showed involvement of VI D to IX D with dense abscess pocket approximately 10 by 15 cm. in size at this level.

I aspirated this abscess October 11. A small trocar was introduced under local anesthesia, between the sixth and seventh ribs just far enough to the left to clear the transverse process of the vertebra. As the trocar passed through, it was directed toward the midline, hugging close to the body of the vertebra. About 100 cc. of purulent material was evacuated in an aspirating bottle. This method of puncture of spinal abscess is different from that of Calvé[18] who goes through the intervertebral foramen. It is, I believe, safer than the Calvé method, so far as danger to the cord is concerned. It would probably not be possible to employ it, however, except in cases where the abscess is demonstrable by roentgenogram and large enough, as in this case, to find easily with the trocar.

Condition January, 1923: Sphincters are now under control. Knee jerks present. Can flex his knees to about 150 degrees and move feet and toes moderately. All movements very spastic.

CONCLUSIONS

In the three cases under tuberculin treatment the temperature was more regular and lower than it was before treatment was begun. Leucocytosis was stimulated in two of the three cases.

No appreciable effect on the sinuses was noticed. These sinuses, however, were secondarily infected.

Sunlight can penetrate the living tissues to some extent. This penetration is greater at higher altitudes than at sea level or intermediate levels.

Direct sunlight inhibits the growth of tubercle bacillus.

The course of the disease is shortened and the patient's general condition is better under heliotherapy than without it.

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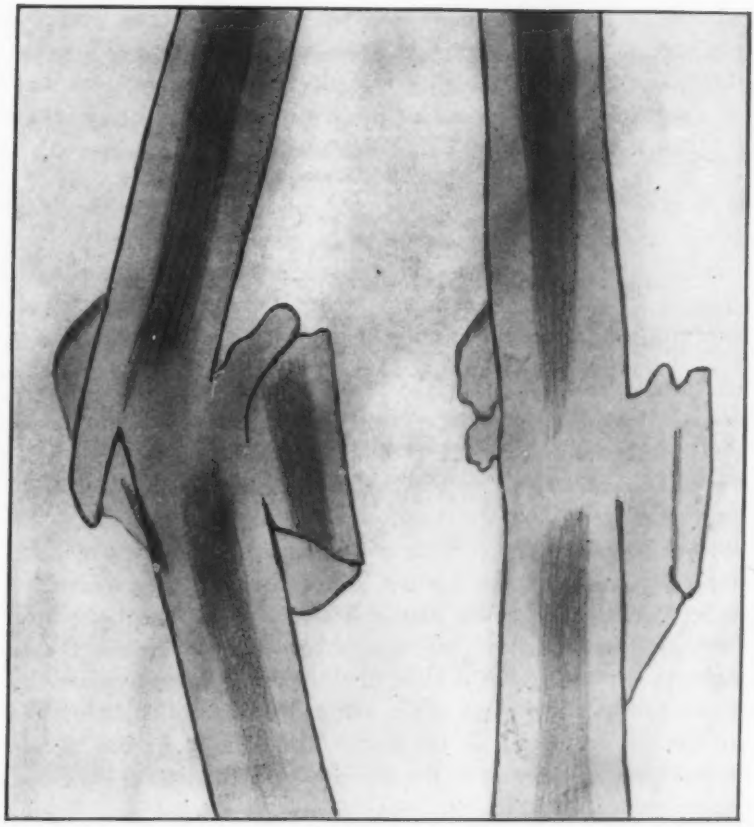
THE LATE CORRECTION OF FRACTURE DEFORMITIES OF THE FEMUR

BY H. WINNETT ORR, M. D., LINCOLN, NEBRASKA

"My experience both in France and in home hospitals compels me to say that the teaching of the principles of treating fractures in general and of their practical application must be vastly improved if ordinary justice is to be done to fracture cases in future. The results of treatment of such cases by those who have become experts in dealing with war injuries show that by careful attention the frequent deformities and consequent incapacities which used to follow comparatively all fractures of civilian life are preventable and should be looked upon usually as due to incompetence or inattention on the part of the responsible surgeon." The above are the words of Colonel H. M. W. Gray, an associate of Sir Robert Jones in the orthopædic service in Great Britain and France.

I think the sentiments of Col. Gray coincide with those of any one thoroughly familiar with our experience in the military service and present conditions in civilian practice. I have no hesitation in saying that both during my service in military hospitals and in my work since that time I am shocked to see how poor the treatment of most of our fractures is. One of the worst features of the present situation is that in general those who treat fractures, whether physicians or surgeons, show a disposition to be satisfied with the methods with which they are already familiar and with the very poor results which they obtain. This is always a fatal state of mind. In spite of the fact, as Colonel Gray points out, that we now have in this country a considerable number of men who can be classed as experts in this line, neither their advice nor their assistance is sought to any considerable extent in the care of these cases. Instead, relief is usually sought by the disabled patient after an avoidable bad result has become or is becoming a fixed deformity.

I am presenting for your consideration to-day certain points in the late treatment of fractures of the femur for two reasons. First of all I wish to establish the fact that the serious deformities which now exist are in many cases remediable. And second, it is desired to point out that the same methods by which these serious deformities and disabilities can be relieved are those which if applied in early treatment will give good results without deformity and without disability. I shall show lantern slides of only a few cases. The con-



Malunited femur after five months; and thirty days after correction by osteotomy and ice tong traction in Thomas splint.

clusions expressed in this paper may be described as impressions, but they are impressions that rest upon the observation of several thousand cases which I have seen treated or which I have helped to treat.

I am now convinced that disability after femur fractures should be the exception instead of the rule, as at present. And I know that the technique of correct treatment and the technique by which good results may be obtained is a comparatively simple matter. The method is one which can be acquired either by physicians or by non-professional men or women in a few days' time. I make this latter statement partly on the experience we had in military hospitals where intelligent nurses and sergeants acquired a proficiency in the treatment of femurs which was often superior to that of doctors who were indisposed to follow details of treatment or who were inattentive to their professional duties in general. Even the use of ice tongs is, as pointed out by Major Pearson, not at all a difficult method.

The exact technique to be employed is as follows,—and this should seldom be varied:—moleskin traction straps, or straps to be fastened to the limb with glue, should be prepared—about three inches wide at the top, about three feet long, and with good rope frayed out and thoroughly sewed in at the lower end for making the traction at the bottom of the splint or cast.

These should be attached to the limb, running well above the point of fracture. In bandaging these straps to the limb, if there is a surplus of moleskin above, it should be turned back down into the bandage. If the Thomas splint is to be used, slip the ring over the foot and up until the back of the ring rests firmly against the tuberosity of the ischium. Keep the limb elevated, maintaining traction while muslin hammocks about four inches wide are pinned across the splint. Let the limb down upon the hammocks, which should be tight enough so that the limb rides well up on the splint. Pull traction ropes down tightly, one going above and one below the bars on either side, and tie snugly at the end of the splint. Put a twisting stick into the ropes about half way between the foot and the end of the splint and twist until there is firm traction on the limb. Bring the lower end of the splint to the outer side of the foot of the bed and turn the limb a little outwards. Fasten the end of the splint firmly to the foot of the bed about six or eight inches above the mattress. Raise the lower end of the bed with blocks or extension legs about eight or twelve inches from the floor. Now suspend the ring of the splint by a rope running through a pulley just about directly over the patient's abdomen and carry the rope through another pulley at the head of the bed so that a weight of ten to fifteen pounds hangs down above the head of the bed. If side pull on the ring is desired a weight of six to

eight pounds may be hung over the side of the bed, attached to the outer side of the ring. Bend the side bars of the splint forward about two inches just above the knee. Be sure that the hammocks across behind the thigh are tight enough so that the femur is bent forward with a natural curve. Finally measure the length of both limbs and twist the traction ropes until the injured limb is as long as the other. Support the foot at a right angle with the leg. Bandage the whole limb snugly into the splint.

If plaster of Paris is to be used—and I usually prefer it—the traction straps are put on in the same way. Anesthetize the patient on a fracture table, attach the traction ropes to the traction device and pull until the limbs are the same length. Put on a double spica to the ankle on the injured side, and to below the knee on the well side. Put a cross bar below the knees between the two legs of the spica. When the plaster has set, turn the traction ropes back over the lower edges of the cast and put on two or three more plaster bandages in such a way as to anchor them, (maintaining traction), and also include the foot thus held in correct position as to rotation of the limb and at a right angle with the leg. Position must be checked by subsequent x-ray through the cast, but if line and length have been secured originally this spica will usually secure healing in six weeks without change in any way. After the patient has been put to bed, the foot of the bed should be elevated and a heavy weight, twenty to thirty pounds, should be fastened to the cross bar between the legs of the spica cast. I find that this contributes greatly to immobilization and to the prevention of muscle spasm in the affected limb. The use of splint or plaster is exactly the same if ice tongs are employed—I usually imbed the ice tongs in the cast just as I do traction straps, and to just as good purpose. I consider the double spica essential.

Length and line are not only fundamental requirements in the treatment of these cases, but they are fairly easily obtained. In spite of this, however, not more than one-tenth of the femur fracture cases that I see under treatment are in correct position as to either length or line. It is a common thing to hear an attending surgeon say after mal-union has developed, that it was impossible to maintain traction. Blame is attached either to the patient or to the apparatus for failure. As a matter of fact the blame for failure to maintain traction should be laid to the surgeon. We do have methods and resources for the control of limbs and for the control of patients which can be made efficient and comfortable. Failure to control the patient may rest upon an excessive amount of suffering or upon a series of disappointments in the early treatment which could have been avoided, and which if avoided, would have made him more coöperative instead of arousing his opposition.

Efficient treatment is not painful. By such treatment relief from pain may always be obtained. It is failure to get length and line and to control movement that causes pain. I am disposed to be very impatient with methods which encourage motion in neighboring joints and at the expense of immobilization of the fragments in a fractured limb. It is my opinion that the excellent results as regards joint movement obtained by Sinclair, Pearson, and others, are obtained not so much because of the fact that they establish early movement, as to the fact that correct line and length have been obtained early and are maintained throughout the course of treatment.

In my own cases I have had the experience of having mal-united femurs come to me with almost completely stiffened knees, and when the mal-union was corrected and correct line and length obtained, a considerable degree of movement returned to the previously stiffened knee. I had one very striking instance of that sort of which I will show you lantern slides.

A man of fifty-four came to me on crutches from Nebraska City in March last year with a mal-united and badly shortened femur (about three inches), which was of about seven months' duration. He came with a history of a comminuted fracture, and also with a statement from two or three preceding physicians that he was an impossible patient to manage. He had been treated by Buck's extension, weights and pulleys, sand bags, etc. X-rays indicated outward bowing with marked angulation of the femur, one large fragment displaced inwards, and a lapping of more than two inches. He had never been able to bear weight on the leg, and there was not to exceed five degrees of knee motion. The lower fragment of the femur was rotated so that the knee pointed almost directly outwards. He was referred to me by his employer and by the Compensation Commissioner, because they were facing the payment of total disability for the remainder of his life, a sum which would have amounted to seven or eight thousand dollars.

This man was placed upon a fracture table and anesthetized with provision for ice tong traction to the femur. Ice tongs were applied and traction begun, then a chisel was inserted into the fractured area, and the old fracture broken up and made to follow the line of the lower fragment in order to give a better opportunity for traction. Upon releasing this fragment with a chisel, strong traction was put on, and we were able to make the leg perfectly straight. The extreme contraction of the soft parts persuaded us to discontinue traction when a length of about three quarters of an inch less than normal had been obtained. The wound was dressed and a double plaster of Paris spica was put on with the ice tongs imbedded in the cast. The patient was quite uncomfortable for two or three days, but had not more than three doses of

morphine altogether. After that he spent about eight weeks in bed, but with no pain or complications. Following this he made daily trips to the office for physiotherapy for about six weeks. He was then walking around on crutches with a caliper splint. No particular effort had been made to move the knee while he was in bed, but immediately upon the application of physiotherapeutic methods knee movement was encouraged, and he has now improved to the extent that he can bend the knee to a right angle without much difficulty. He has been going about as he pleased without braces or crutches now for many months, and is practically a well man. He made a settlement with his employer and with the Compensation Commissioner on a basis of 25% disability some months ago.

We have been taught that we are to expect a man with a fracture of the femur, especially a compound fracture, to be permanently disabled for labor. I am prepared to state that this is not true at all. Early adequate treatment with the limb in correct line and full length, will give as good results in femur fractures as in fractures in any other part. Backward or outward bowing of the femur and external rotation of the lower fragment with shortening are the common faults. These can be entirely overcome by correct use of the Thomas splint. In most of these cases, moreover, control of the fracture becomes less efficient with attempts to move the knee, and my advice is that the knee should not be moved until after union of the fracture in correct line and correct position has been obtained.

I firmly believe that if no attempts had ever been made to establish early motion of the knee in femur cases, our results now would be better than they are. I will admit that there are those like Pearson, for example, who mobilize knees early and succeed in controlling the fracture at the same time. But the attempt to do this on the part of most of those that I have seen destroys the efficiency of the treatment of the fracture and leads to worse rather than better functional results for the limb as a whole.

In a general way my experience leads me to conclude that any patient with a mal-union of the femur who has been disabled to the extent of being on crutches, should be given the benefit of an osteotomy and correct treatment. A man with three and one-half inches of shortening, for example, and with outward bowing, or with an external rotation of the lower fragment, will be very greatly improved by an osteotomy which will correct his bowing and give him an inch or two of length. If the shortening can be lessened so that the patient has shortening of less than an inch, and if any considerable degree of deformity can be overcome, the operation is worth while. If the traction can be accomplished with or without osteotomy at the time of opera-

tion, and a Thomas splint applied in such a way as to maintain the correction and the length obtained, the patient's suffering will be all over within twenty-four to forty-eight hours, and there is nothing to do but to give him six or eight weeks of waiting for a very good result.

On the point of convalescence I have an opinion that differs somewhat from those commonly found in the literature, which state that in these fractures six months to a year must elapse before the patient can bear weight on the limb. We commonly put these patients on their feet in a walking caliper splint in eight to twelve weeks, and expect them to be well in less than six months. Of course, if there is deformity, or if there is much shortening, or there has been so much movement that union is incomplete, a much longer period of fixation and protection will be necessary.

It must be taught, however, and should be taught uniformly and generally by the members of this Association, that mal-unions of the femur, as well as early fractures, may and should be correctly treated so as to obtain correct line, full length, and early recovery by methods which are now available to all. Moreover, any earnest student, either doctor or nurse, can become thoroughly familiar with the necessary technique in a few days time. There is no excuse in the light of our present experience for the poor treatment of femur fractures, either early or late, that is still to be found in every city and village in this country. It is time for us to entirely abandon the double inclined plane, the Liston splint, the Hodgen splint, weight and pulley traction, sand bags, and all the other devices which fail to comply with the fundamental demands of all treatment in fractures of the femur and especially in the treatment of those late conditions where ideal treatment must be the rule.

SOME CONFESSIONS OF AN INTERNIST REGARDING BODY MECHANICS.

BY ROGER I. LEE, M. D.

Henry K. Oliver Professor of Hygiene, Harvard University.

When I came to Harvard University in the fall of 1914, as Professor of Hygiene, I had, I presume, the common conservative attitude of most internists towards orthopaedics. During my Medical School course, my hospital internship, and some years of private and hospital practice, I had watched with the interest of an aloof spectator the development of the specialty of orthopaedic surgery. At the hospital with which I was connected I had seen orthopaedic surgery grow from a weekly visit by an orthopaedic consultant to a very active service. Of course I accepted the orthopaedic treatment of bone tuberculosis and of other bone and joint deformities and also accepted the field of operative orthopaedic surgery. The kind of orthopaedic surgery, however, which is commonly known as medical orthopaedics had not made any very great impression. I had recognized, of course, that in connection with the improper use of the feet various symptoms might well occur and that the orthopaedic surgeon was frequently able to relieve these symptoms. On the other hand, I had not failed to observe that in orthopaedics as in any other branch of medicine there were not only different schools of procedure, but also varying fashions. I viewed with frank scepticism the suggestion that orthopaedic functional disturbances, such as bad posture for example, were connected in any important degree with the fundamental well-being of mankind.

Fortunately when I came to Harvard University it was necessary for me to build up an organization for the care of the student health. I say fortunate because it was possible to accumulate considerable data while working out the fundamental procedures. One of the first steps in the new organization, since the ill were already taken care of, was to create a system of physical examination. This was begun on more or less conventional lines with a strict insistence on medical thoroughness. These medical examinations brought forth many problems. In a general way the most important problem was the creation of a standard for the healthy members of the group being examined. That problem still continues. A considerable portion of the energy

*Given in substance before the Boston Orthopædic Club, May, 1922.

of the department has been devoted to the investigation of such problems as the occurrence of albuminuria in young men, the instability of blood pressure in young men, the existence of athletic heart, systolic murmurs in normal individuals, etc. With the analysis of the findings of the first group of students examined it became evident that the occurrence of positive organic disease was relatively small: that is, under five percent. However it was perfectly evident that although ninety-five percent of the College population were organically sound, in that no organic defects could be found in any organ or tissue of the body, nevertheless ninety-five percent of the College population were not entirely robust, healthy individuals. At once it became apparent why such tests as the strength test had been introduced into many of our universities as a precautionary measure against the promiscuous participation of the ninety-five percent in athletics. However, the strength test, which is a test of the musculature of the individual, has very apparent faults. It did not seem to be enough that the individual should be organically sound and that he should have certain muscular strength in order that one should be entirely satisfied with his well-being. It seemed reasonable to assume that the strength test was only supplementary in a very limited sense. In other words, an organically sound individual might, by dint of hard practice, surpass a fixed standard in the strength test and probably be not considerably improved over his previous condition. Upon reflection it appeared that a medical examination which detected the presence or the absence of organic defects must be the foundation stone of any critical survey of the individual. But that was the beginning of the problem.

Certain data, mainly along statistical lines, among school children had attracted a great deal of attention to certain standards of nutrition, and rather explicit ratios were suggested, taking into consideration, height, weight, and age. It seemed to us that, on the whole, these ratios were rather arbitrary and that more work needed to be done in this field. We have ourselves made certain investigations in the hope of putting the standard of the nutritional state on a more scientific basis. Even at best, however, the nutritional state is but one phase of the problem of well-being.

I have attempted elsewhere[1] to discuss some of the data secured by scrutinizing the various physiological systems of the body for the purpose of attempting to evaluate the well-being of the individual as a whole. Of course, these systems are very closely interrelated. It also seems certain that the most important system in determining the well-being of the organically sound individual is the central nervous system. In our attempts to evaluate the efficiency of the various physiological systems we have turned our attention

to what has been designated as body mechanics. In dealing with large groups of individuals it has been necessary to restrict somewhat arbitrarily the scope of our observations. We have desired to secure data which could be introduced into an ordinary physical examination. This necessitated that the observations should not be time consuming, should be capable of being carried out by examining physicians who were not specialists and should, if possible, be capable of classification into groups. Dr. Lloyd T. Brown personally made tracings of 746 individuals during one examination season and was able to classify these individuals into four groups, A, B, C, and D, according to the mechanical use of their body, as far as the standing position was concerned. This is obviously only one feature of body mechanics. During some subsequent physical examination periods, using Dr. Brown's charted classification as a standard, the examining physicians undertook to rate all individuals examined. Experience showed that this method was entirely feasible and yielded quite consistent results, even with different and changing examining physicians. As an internist, however, I was far from convinced that this classification was necessarily of real significance. In other words, the question whether it was anything more than of cosmetic value that the individual stood poorly was still undetermined. Sufficient time has now elapsed, however, so that one can generalize concerning the value of this classification. Of course, it must be appreciated that very bad standing position is not necessarily associated with either local or constitutional symptoms. This aspect Dr. Brown and I[2] have discussed in a short paper, "Correction versus Compensation of Body Defects." It is clear that a structural defect of the spine may be largely or entirely compensated for by large muscles. It is also clear that poor function of the spine may be either corrected or compensated. Our experience indicates that compensation by muscles is the rule in the College youth who stands poorly. Most back aches in the college youth are traumatic or infectious in origin. The back aches which are not traumatic or infectious seem inevitably associated with very bad body mechanics. Experience also shows, rather to our surprise, that functional disturbances of other systems, for example, vasomotor instability or even nervous instability, tended to be associated with poor function in body mechanics.

There is one functional disturbance which I desire to mention more in detail. Ever since we began physical examinations in 1914 we have been very much interested in the occurence of albuminuria in apparently healthy young men. It became evident early that such an albuminuria without the other signs of nephritis was of no serious moment. It also became evident that it did not occur in the best physical specimens. In following up these cases of albuminuria, which occur in as high as six percent in the Freshmen,

we find that there is general tendency for albuminuria to disappear with age. There are certain individuals in whom the albuminuria persists. This albuminuria is present throughout the day but is not present in the early morning after a night in bed, and is usually called functional or orthostatic albuminuria[3]. Our investigations have not been concluded with this interesting group of cases, but it seems reasonable to assume that these individuals show albumin on very slight activity, whereas it is well known that the ordinary individual requires very violent exercise to show albumin. In checking up these individuals with orthostatic albuminuria it was surprising to find that a considerable proportion of them had been previously classified as having very bad body mechanics and were in our group "D." I am certainly not prepared to state that the bad posture is the cause of orthostatic albuminuria; I am only prepared to state that the two conditions are often associated. It seems likely that the poor function in one system is merely associated with a poor function in another system. It is only fair to add that it has not yet been determined how far the correction of bad body mechanics will go towards removing the albuminuria. The association of bad body mechanics with other functional disturbances of other physiological systems is sufficient to make us believe that the classification of bad body mechanics is of definite value. I do not believe, of course, that the classification of an individual's body mechanics is a classification of the individual as a whole, but it seems to me that it is an important contribution to the evaluation and survey of the individual as a whole.

Very bad body mechanics is naturally of more significance when it is associated with a disturbance of function of another system. It is possible to have very bad body mechanics without disturbance in another system. How long the body mechanics may be compensated for without local disturbance or without associated disturbances, it is not possible to say. It is certain that many persons go through life with very bad body mechanics and apparently without positive ill-health therefrom. On the other hand the experience with bad body mechanics in middle life, when the bad habit has become fixed, is a strong additional argument for the early correction of this condition. It is interesting in this connection that, as one might expect, there is a high correlation between good body mechanics and athletic prowess. It is also interesting that there is some correlation between good body mechanics and the intelligence rating in one of the graduate schools of the University. The latter point deserves some emphasis because of considerable confusion arising from a misinterpretation of certain data. The obvious fact has been given great emphasis that the ability to attain high excellence in such physical

performances as jumping and running is not associated with high scholarship[4]. I say "obvious" because one would expect that technical excellence in given physical events would, as a rule, be attained at the expense of technical efficiency and interest in scholarship and vice versa. As physicians interested in health we are not primarily interested in technical or trained physical excellence but in general well-being.

As I have tried to indicate, I do not believe that such a method as has been outlined does anything more than form a basis of evaluation of one part of one physiological system. That the method is crude and rough and deals in generalities is certain. Any form of classification into large groups is bound to deal in generalities. This method does not discriminate sharply between different types of individuals, more notably the thick set and the slender individuals. Nevertheless, despite obvious short-comings, such a method has won favor in my somewhat sceptical eyes, and it seems to me very useful not only in the examination in large groups but in the critical survey of individuals in a general practice. As far as I know, the examining physicians who have assisted me in the examinations not only have become convinced of its value, but have found such a method useful in private practice. To my mind the greatest danger is in over emphasis of such a method by attaching to such an evaluation of one physiological system more value than it should have. The total evaluation of the physical activities of the individual, while taking the evaluation of the body mechanics into consideration and serious consideration too, will also take cognizance of many other factors.

We have attempted to utilize this general method to evaluate the use of the feet. From the nature of things the use of the feet represents much more of a local problem. It is reasonably certain that poor use of the feet is much less closely related to possible constitutional disturbances than poor mechanical use of the body. By poor use of the feet we, of course, mean poor use of the feet from an orthopaedic point of view, not merely absence of transverse arches or low posterior arches. Symptoms develop much more rapidly from poor use of the feet than from poor standing position. There is, however, the same factor of muscular compensation for poor use of the feet as has been discussed in poor standing position. There did not seem to be any close association between poor use of the feet and functional disturbances of the body, but, as one would expect, there was some association between poor use of the feet and poor standing position. Our experience has indicated that any arbitrary classification into four general classes of the use of the feet is roughly satisfactory both in large groups and individually. Perhaps the most encouraging feature of this aspect of our work has been the ease

with which good habits of the use of the feet can be substituted for bad habits by a little instruction and encouragement both before and after there are symptoms. Our experience indicates that the feet with which not much fault can be found and which are generally passed as representing fairly good use may need definitely more instruction than it has seemed necessary to give in the past. Other factors such as shoes, which we always investigate, and strain on the feet, such as prolonged standing or running on hard surfaces, must be taken into consideration.

In conclusion, a conservative view point would seem to be that bad body mechanics as far as it concerns posture and the use of the feet does not under the artificial conditions of our present day civilization tend to correct itself spontaneously. Whether the underlying cause for the failure of Nature to secure correction is to be found in the home, in the school, or in uncorrected habits after illness, is not apparent. Seemingly a majority can be benefited by intelligent instruction in good habitual use of the body and the feet. Inasmuch as habits once formed are difficult to break, it is important that good habits be established as early as possible. It would seem to be important to establish good habitual use of the body and feet in the growing period or in the schools and, of course, before college age. Our experience definitely indicates that such measures which are entirely feasible will presumably show excellent results in middle life. Finally again it must be emphasized that important though the body mechanics is, it is only one of the systems of the human body, and any evaluation that confines itself to one system will leave out of consideration many factors that may be of paramount importance.

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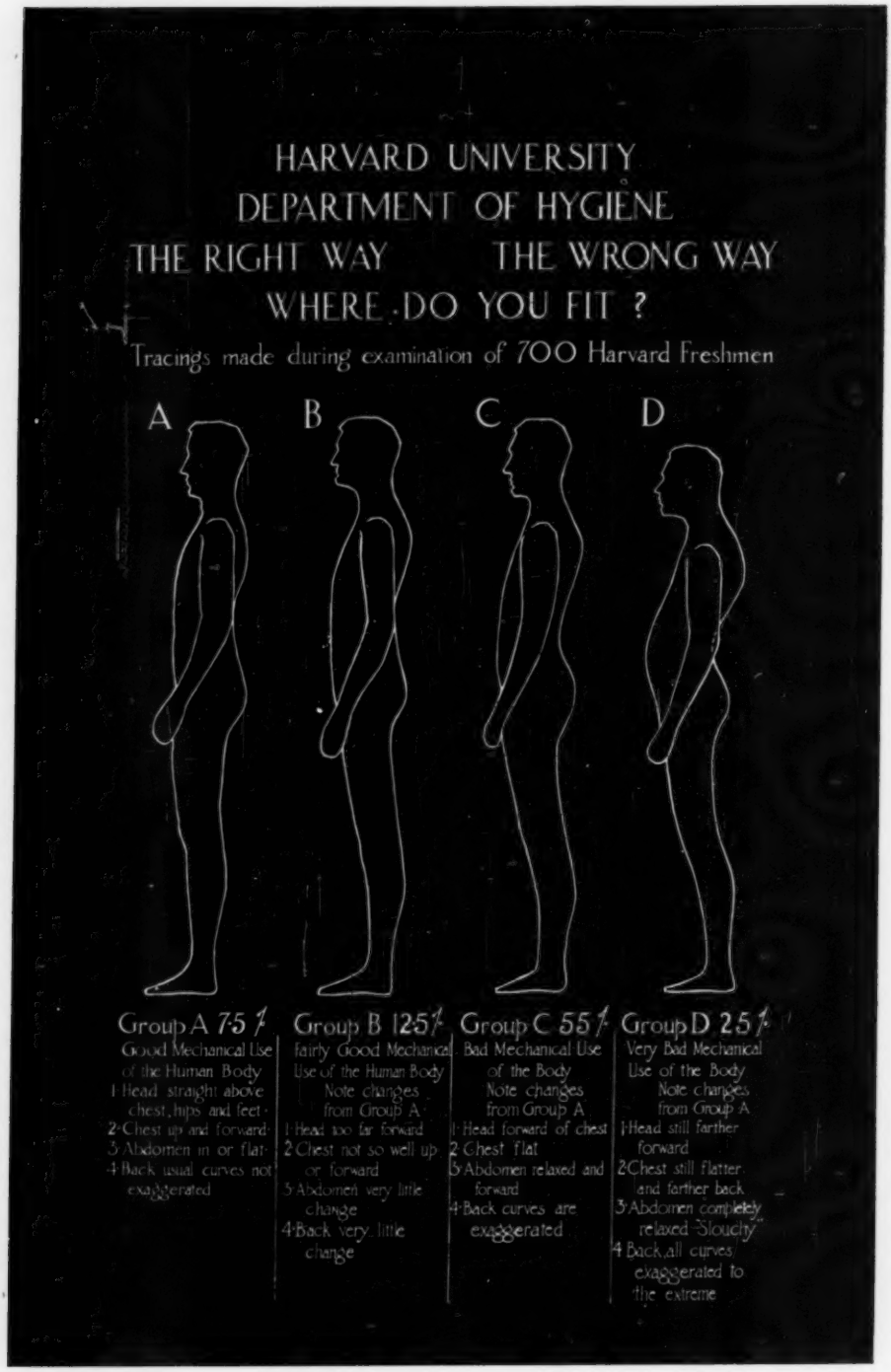
A NEW CHART FOR THE STANDARDIZATION OF BODY MECHANICS.

BY ROGER I. LEE, M. D., AND LLOYD T. BROWN, M. D.

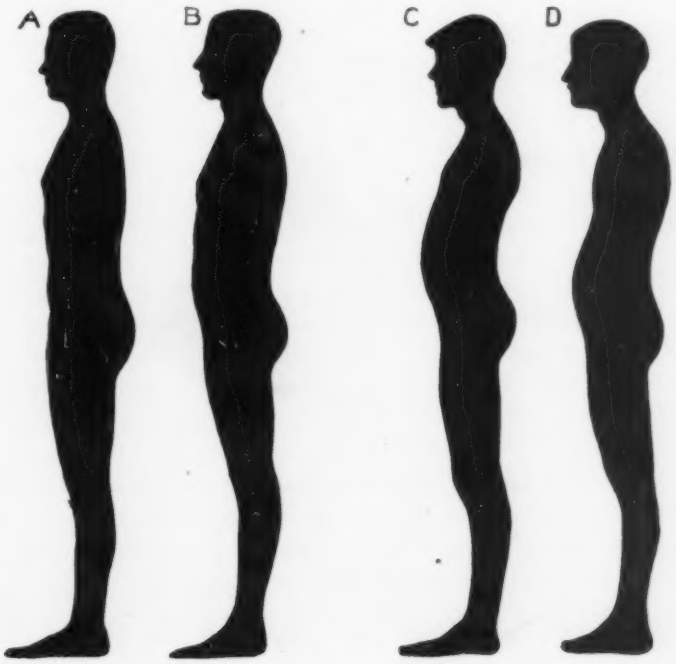
Some years ago the Department of Hygiene at Harvard University, in connection with the regular physical examinations, found it practicable to have a method of standardization by which it was possible to make fairly quick and accurate judgment of the body mechanics of each individual examined. A chart (Figure 1) was developed by Dr. L. T. Brown[1] from tracings made from 746 individuals who presented themselves for examination in October, 1916. Experience with this chart used as a standard has shown that it is possible to get fairly uniform and consistent results over a series of years with different groups of students and with different examining physicians. It has furthermore been our experience that the rating by the examining physicians corresponds very closely to the rating given on the basis of tracings. The method used is that the examining physician rates how the individual uses his body during the period of examination, particularly when the individual is relaxed and is not making a special effort to show how much he thinks he knows about the correct use of his body. This point seems important because, on the one hand, some students, who habitually use the body badly, have been coached how to take a good mechanical position and so assume it when they think it is necessary, and because, on the other hand, some students, who habitually use their bodies well, will artificially assume a very incorrect position when attempting to stand well. The method of continuous observation has this advantage over the method of securing tracings, in that it seems to be a fairer test of the habitual use of the body.

Although the old chart, (Figure 1) has been on the whole very satisfactory, nevertheless, it has several very definite faults. The most marked fault seems to be in Figure A. Figure A represents what should be essentially perfect body mechanics. Comparing the old chart with the new one, (Figure 2) the difference between the two can be easily seen. Furthermore, the new chart is made from individuals who belong to the type of narrow, thin individuals. This type is chosen because it is the type in which for anatomical reasons the most marked changes can be seen, and this type is commonly found in the "D" group, or those with bad body mechanics. It is not feasible, and in our experience it is not necessary, to have different sets of charts for the different


HARVARD UNIVERSITY
DEPARTMENT OF HYGIENE
THE RIGHT WAY THE WRONG WAY
WHERE DO YOU FIT ?
Tracings made during examination of 700 Harvard Freshmen
A
B
C
D
Group A 7·5 %
Good Mechanical Use of the Human Body
1 Head straight above chest, hips and feet
2 Chest up and forward
3 Abdomen in or flat
4 Back usual curves not exaggerated
Group B 12·5 %
fairly Good Mechanical Use of the Human Body
Note changes from Group A
1 Head too far forward
2 Chest not so well up or forward
3 Abdomen very little change
4 Back very little change
Group C 55 %
Bad Mechanical Use of the Body
Note changes from Group A
1 Head forward of chest
2 Chest flat
3 Abdomen relaxed and forward
4 Back curves are exaggerated
Group D 25 %
Very Bad Mechanical Use of the Body
Note changes from Group A
1 Head still farther forward
2 Chest still flatter and farther back
3 Abdomen completely relaxed Sloucty
4 Back, all curves exaggerated to the extreme

variations in the type of individuals. It must, however, be appreciated that the stocky thick-set type is quite different from the narrow thin type and that there are anatomical variations of the bones and muscles which make a difference in the amount of relaxation possible.

The legends under the figures on the chart explain the special point of each and are followed in making the ratings. The individuals who have been rated as "D" have in the past been given a special examination in the gymnasium, where a graphic record was taken. There have been very few discrepancies between the graphic records and the ratings at the time of the examination. This group rated as "D" has had the benefit of special instruction in body mechanics. Our experience has convinced us that a rating of "D" is certainly a potential handicap. It is our experience, furthermore, that with the reasonable coöperation it is nearly always possible for a "D" individual to improve his rating. The justification of such endeavors is becoming more clear with the accumulating evidence that the muscular compensation of defects in body mechanics, which is so common and so easy in youth, not infrequently fails when active physical exercise is given up for a sedentary life. This feature has been discussed by us elsewhere[2].



Some form of graphic record is often very valuable for a variety of reasons. The graphic record furnishes a permanent record for purposes of comparison. It is frequently of great value in gaining coöperation in attempts to achieve correction of bad body mechanics. The graphic record can be used furthermore as an excellent check on the accuracy and consistency of ratings by observation. A new method of taking the graphic record has been worked out by Norman W. Fradd of this Department. This method is very quick, inexpensive, and accurate. It does away with the personal equation which is such a large factor where tracing an image is necessary.

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A NEW METHOD OF RECORDING POSTURE

BY N. W. FRADD

Instructor, Department of Physical Education, Harvard University

In the physical-medical examination of Harvard Freshmen an attempt is being made to classify them regarding their body mechanics from an orthopaedic standpoint. Examinations of the past four years have annually placed one third to one quarter of the class in a "D" rating, which signifies very poor body mechanics. This rating also carries with it the opportunity of special exercises and instruction sometime during the winter months. In an effort to demonstrate to the individual the need for improvement a tracing camera has been used, and each Freshman classified "D" is given a tracing of himself. This hand tracing camera is poor at best and, although used extensively, is inaccurate and wastes much time.

During the past year experiments have been carried on at Harvard in the Hemenway Gymnasium by the writer and a photographic expert to record the posture of Harvard Freshmen given the rating of "D." Realizing that photography was by far the most accurate and satisfactory method to use, though expensive, it was our aim to produce an actual photograph with the minimum expense, eliminating the services of a photographer in printing and developing. The operation must be short with reference to time, and the record must be accurate to be of any permanent value. The outcome of these experiments has been the development of a camera and other features which give the desired result.

The camera is sold under the name silhouetteograph*. The picture produced for record is an actual silhouette. The use of a film or plate in the camera is eliminated by substituting a sensitized bromide paper which can be put through the developer and fixing bath in two or three minutes, after which the picture is ready for inspection, criticism, or commendation. One of the features of the camera is a movable plate holder which allows for one, two, four, or twenty-four exposures on five by seven inch paper, depending upon the size of the picture desired. It can be seen at once that with such an arrangement the camera is adaptable for use in private clinics or public schools.

The space required for making a picture like the one suggested above is about fifteen feet long by six feet wide. In setting up the outfit an electric bulb of 1000 watts in a suitable reflector is placed about five feet behind

*The equipment used by the writer was obtained from Robey French Company, Boston, Mass.

a screen made of architects' tracing linen. (Linen is used because it is a better diffusing surface than cotton.) The screen should be about seven feet long and three feet wide supported on a frame or shade roller. The lighting source should be moved forward or back and raised or lowered to give an even distribution of light on all portions of the screen. The distance between the screen and the camera is about ten feet. With the apparatus set up as described the subject stands close to the screen in the space between camera and screen, with the right or left side of the body toward the lens.

The picture obtained is an actual silhouette reversed; that is, the subject is white on a black background instead of black on a white background. The time required for the exposure is about five seconds. This is governed somewhat by the intensity of illumination in the flood light and the speed of the lens. To obtain the best image the space between the camera and the subject should be darkened to give a clear sharp silhouette. The pictures may be numbered for filing or identifying by inserting a stencil at some convenient place on the diffusing screen.

The matter of expense is, as stated above, a drawback when pictures are considered. The actual expense of this entire operation is about one cent or less per picture, depending upon the size.

The writer considers it a great advantage to produce the picture for inspection by the subject immediately after taking. The impression made on the subject that "probably there is room for improvement" paves the way for instruction, whereas any amount of talking or looking in mirrors might prove ineffective. The interest of the student is at once aroused, and with a bit of tact the instructor has the opportunity to suggest ways and means of correction. Successive pictures may be taken to record improvement in posture. With a slight change in lighting effects lateral deviations of the spine may also be recorded.

ACTINOMYCOSIS AND BLASTOMYCOSIS OF THE SPINE.

BY CHARLES A. PARKER, M. D., CHICAGO, ILLINOIS.

An undiagnosed case of blastomycosis of the spine, with a fatal ending, in my practice a few years ago, and a previous undiagnosed case of actinomycosis of the spine, also terminating fatally, are my reasons for presenting the cases in question, along with a discussion of the conditions under which these rarer affections of the spine occur.

Although the occurrence of general infections in these diseases has been known for some time and the spine recognized as an occasional site of infection, it seems worth while at this time to emphasize the spinal feature and bring together the scattered records of such of these cases with spinal involvement as have from time to time appeared in the literature. The writer does not know of such a special compilation. Such an assembling of isolated instances of related facts serves to concentrate the attention upon the subject and give anew its proper perspective in the medical view.

ACTINOMYCOSIS.

To Bollinger, of Munich, (1887) is given the credit for discovering the nature of the infection in lumpy-jaw cattle. The following year Israel discovered a similar organism in man, which Ponfick shortly after found to be identical with that discovered by Bollinger, thus demonstrating the same causative factor of the disease in man and the lower animals. These were the real discoverers of the true nature of the disease. Following these investigations, a number of undiagnosed clinical cases in man and animals that had occurred before this time were brought to light in the Italian, French, English, and German literature. Israel quotes Langenbeck, as far back as 1845, as describing a case of caries of the lumbar spine with yellow grains in the pus and other characteristic features. Israel believes this was undoubtedly actinomycosis.

Perhaps this is the earliest spine case of which we have any record.

Following the studies of Bollinger and Israel, reports of the disease in man began coming in from various countries on the continent of Europe, later from England, in 1884, and then from the United States, in Chicago, in 1885. It has since been found in most of the countries of the world. The presence in the pus of sulphur colored, white or greenish microspic to

pin-head-sized granules containing the specific ray fungus, or recognition of the organism in the tissues, establishes the character of the infection.

No attempt will be made to repeat in detail the well known clinical features of the disease but attention is called to Ruhrah's statistics published in 1899, reporting 1094 cases. In 421 of these collected by Inich, the sites of distribution were as follows: Head and neck 56%, pulmonary 15%, digestive tract 20%, skin 2%, doubtful 6%. This enumeration does not mention the spine, as it evidently refers to the site of the principal disturbance, although he does state that the spine is the favorite site of bone lesions. In quoting the same statistics two years later, Erving says the ribs and vertebrae were affected in 9 cases, or in a little over 2%. These are the best reviews in the literature covering particularly the United States and Canada, with much detail regarding geographical distribution and other important statistical information. (Later.) A review by Sanford, *J. A. M. A.*, Aug. 25, 1923, of 678 cases in the United States has just appeared. Spinal invasion is not mentioned.

In a careful review of the literature since the publication of these reports the writer has been able to find but seven reported cases of definite infection of the spine. To these may be added one unreported case and the one herewith reported by the author, making a total of nine. A compilation of all cases of actinomycosis in man since 1902 was not attempted, so the percentage of spine cases was not determined. It is plainly evident that many more spinal cases than those reported have occurred, yet the small number reported shows that its recognition as a clinical feature is not common. This is largely due to the fact that the invasion of the spine is always secondary and its symptoms are usually obscured by the more obvious primary manifestations, and to the equally unavailing fact that deformity of the spinal profile rarely occurs. The invasion of the spine may be determined by the localized pain, cord symptoms, rarely deformity, and by the use of the x-ray. Often it is found only at autopsy.

A short résumé of these later reported cases will furnish a good composite pathologic picture of the local changes and accompanying symptoms.

Summary of Cases.

Boström's case, 1890, was that of a woman 40 years old, who, besides other thoracic symptoms, had severe pain in the thoracic spine with abscesses and numerous fistulae in the back. At autopsy the spinous processes were found more or less carious and softened. The dorsal vertebrae from the 1st to the 8th showed loss of periosteum. The bodies were markedly carious, soft, and easy to cut with a knife, with large and small cavities filled with granulations. Corresponding heads and portions of the ribs were cari-

ous. No osteophytic growths were observed. Slight compression of the bodies in places was observed, being most marked in the 8th. The accompanying illustration taken from his article is classic. Fig. 1.

Ginsberg's first case, 1890, was that of a woman 40 years old. She suffered from pain in the chest and back, which was followed by abscesses and fistulae. The post-mortem showed worm-eaten cavity building destruction of the spine extending from the 2nd to the 8th dorsal vertebra, causing a scoliosis to the left.

The transverse processes and ribs at their angles were also affected.

The second case was in a male 6 years old, with abscesses and fistulae along the spine.

Beside the lung infection, the post-mortem showed erosion of the upper dorsal vertebrae and ribs.

In Bevan's case, 1905, the post-mortem report on the distribution adds "then the sacrum, spinal column and cord". There is no mention of change in the spinal profile.

J. K. Young's patient, 1908, was a man 31 years old. No kyphosis was present and movements of the spine were normal. There was swelling of the dorsal tissues with sinuses. X-ray showed "superficial lesion of the angles of the 2nd and 3rd ribs, left side, but no lesions of the vertebrae." Autopsy disclosed "many small and large abscesses in the muscular tissue and intermuscular tissue beneath the periosteum from the 1st cervical to the 1st lumbar vertebra. The 10th dorsal vertebra was denuded of periosteum and communicated with a large cavity. The spinous processes of the lower dorsal vertebrae were infected."

Kolacek, 1914, mentions the 1st to the 3rd lumbar vertebrae being eroded, with a perinephritic abscess.

Guleke's case, 1921, was that of a man 53 years old, suffering from neuralgic pain in the left side of the chest. Early x-ray was negative. Two years later x-ray showed changes in the 3rd and 4th dorsal vertebrae with reflex spinal rigidity and slight right sided scoliosis. At operation, the 2nd and 3rd dorsal vertebrae were found "highly carious" and were scraped out. This healed. Two years after this another operation was performed, with recovery of the patient. He states he has not observed in the literature a deforming of the spine from actinomycosis.

The unreported case, 1922, occurred on the service of Dr. Dean Lewis in the Presbyterian Hospital. The patient was a woman, 30 years old, with sinuses on the back discharging pus from the deeper structures, presumably the kidney. Autopsy disclosed an abscess connected with the left kidney and direct extension of the infection to the bodies of the 12th dorsal and

the first four lumbar vertebrae on the left side. The 1st and 2nd lumbar vertebrae were one-third destroyed on this side. The process was found in the lungs. There was no deformity of the spine. The diagnosis was made from the autopsy material.

The author's case. The patient was a male, aged 22 years, a farmer by occupation and a resident of Michigan. He was first seen in October, 1913, giving a history of an operation for appendicitis the previous May. The wound had not healed and there was a copious discharge of pus, with other collections of pus in the lower right side of the back. For this condition he was sent to the Presbyterian Hospital and the abscesses drained. Repeated examinations of the pus did not reveal the true cause of the infection. The patient died six weeks after entering the hospital. A few days before death there was some loss of control of the lower extremities, but no deformity was present in the spine and no symptoms had been attributed to it. No x-ray was made. The following is the pathologist's report: "There is a large cold abscess surrounding almost the entire lumbar spine and extending downward in either psoas muscle to the inguinal region. The muscles attached to the spine both laterally and posteriorly are extensively broken down and infiltrated with yellowish pus and granulations. The sides of the bodies and transverse processes of the vertebrae are extensively eroded and covered by the same granulation tissue. On sagittal section of the lumbar spine the erosive process is found to extend through its bodies, and a large granuloma has formed between the anterior surface of the dura and the posterior surfaces of the bodies of the 3rd, 4th and 5th lumbar vertebrae. This grayish yellow granulomatous tissue has almost completely collapsed the dural canal from front to back and has compressed the enclosed fibers of the cauda equina. The inner surface of the dura and the contents of the dural canal are uninvolved by the inflammatory process. The nerve roots outside the dura are surrounded by granulomatous tissue. The intervertebral discs show only slight changes. See Figs. 2, 3 and 4.

Microscopic Findings: Sections of the infiltrated bone and of granulations surrounding the vertebrae show typical actinomycotic changes. There are areas of bone destruction by lacunar absorption with replacement by granulomatous tissue composed of round and epithelioid cells, fibroblasts and degenerated tissue. Occasional colonies of ray fungi are seen, surrounded by an inflammatory zone. See Fig. 5.

A more skillful search by the pathologist of curetted materials or an x-ray would in all probability have revealed the true condition. Had this been done early, cure might have resulted.

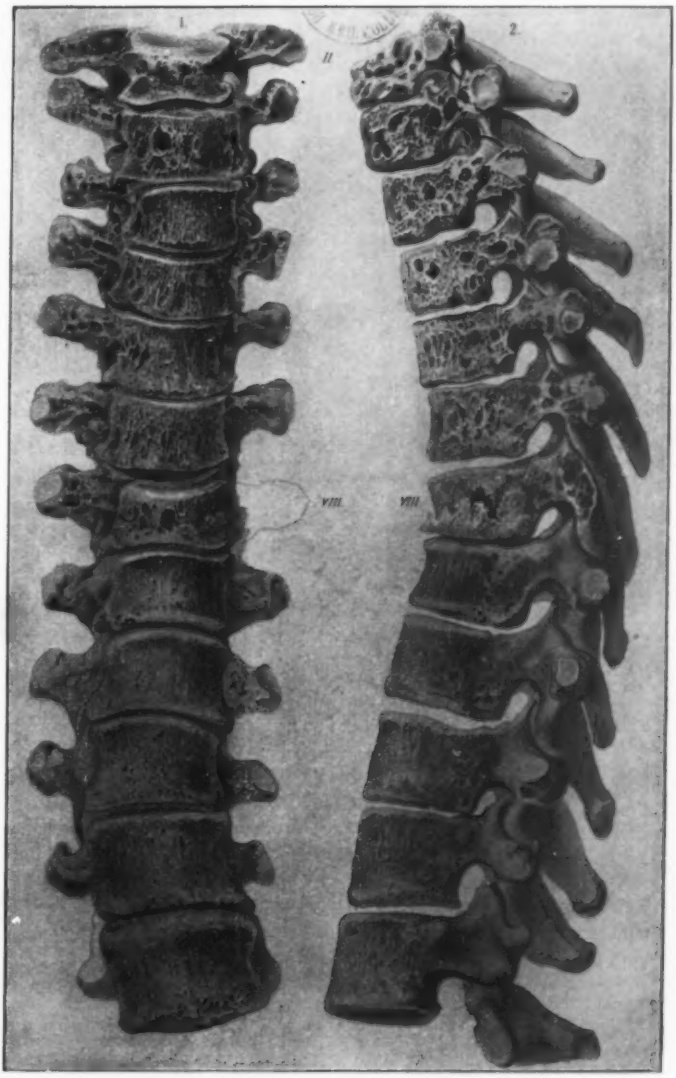

Figure 1. Boström's classic illustration of actinomycosis of the spine taken from the Beiträge zur pathol. Anatomie, Bd. IX.

Diagnosis.

In Guleke's case and in Ginsberg's case slight scoliosis was mentioned, and in Boström's case a slight deformity could possibly have resulted from compression of the vertebrae, but the amount of compression was so slight that the deformity could easily have escaped recognition. In Guleke's case much of the 2nd and 3rd dorsal vertebrae was curetted out with little tendency to collapse. In none of the other six cases were there any symptoms directly referring to the spine, unless the late paralysis of the

Figure 2. Actinomycosis of Spine. Gross specimen showing position of psoas abscess with breaking down of muscular tissue and erosion of the vertebrae.

lower extremities in the author's case. Thus it is evident that little help is to be derived from changes in shape of the spine although it is said that the deformity may resemble that of Pott's disease.

Spinal symptoms appearing in a patient known to be suffering from actinomycosis should naturally suggest the possible cause of the spinal disturbance and determine the necessary local diagnostic measures, such as

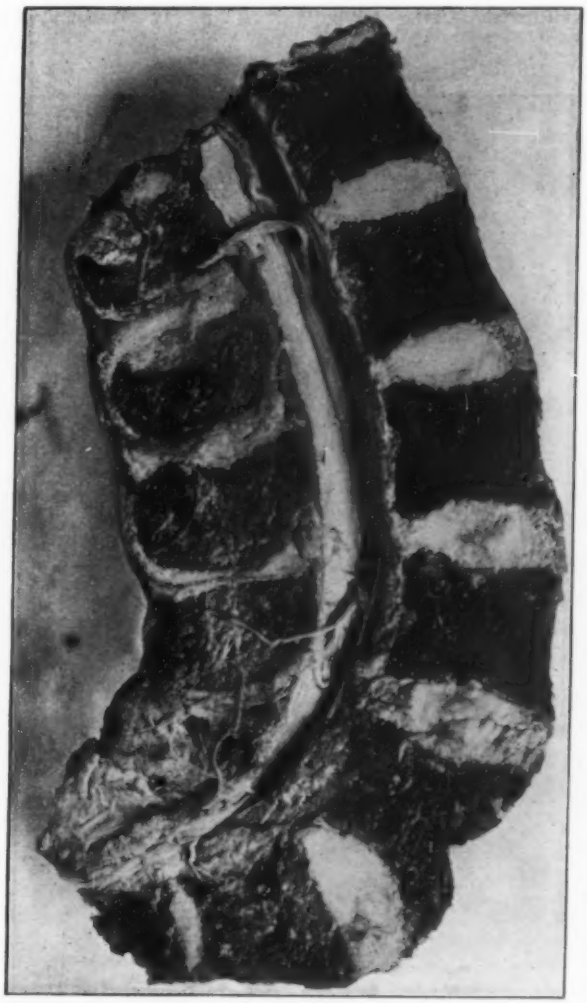

Figure 3. Sagittal section showing extent of osseous invasion and destruction. A large granuloma lies between the anterior surface of the dura and the posterior surfaces of the bodies of the 3rd, 4th and 5th lumbar vertebrae. This has compressed the cauda equina.

x-ray and possibly examination of curetted material to decide the causative factor.

Similar spinal symptoms in a person suffering from an undiagnosed general infection would put the diagnosis one stage farther away, necessitating first the diagnosis of the general condition and then of the spinal.

In occult cases where the spinal conditions predominate, all possible factors must be considered, actinomycosis among them. The x-ray will play an important rôle in the decision. Perhaps serologic reactions may eventually come to our aid.

Figure 4. X-ray of specimen showing the peculiar patchy appearance of the affected areas in all the bodies and pedicles without collapse of the bodies, an appearance unknown in tuberculosis.

Treatment.

The treatment depends upon the orthopaedic condition presented. If there is deformity, such protective measures as are used in Pott's disease should be considered. With compression of the cord, laminectomy would be indicated. Guleke curetted out the centers of the 2nd and 3rd dorsal vertebrae and obtained the only recovery in this group. General measures are operative, with the use of large doses of potassium iodide.

Prognosis.

The prognosis is necessarily grave, as the spinal infection is secondary to an already developed focus elsewhere. As stated above, all the patients but one died from the infection. In the 100 cases of generalized infection reported by Erving, 45 recovered; improvement took place in 14; no improvement in 9, and death was recorded in 32 cases.

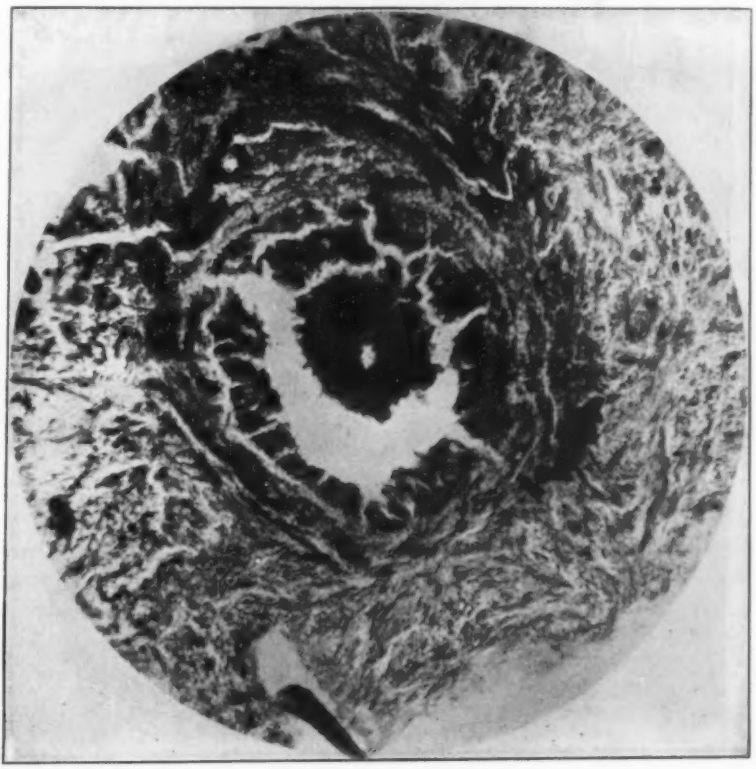

Figure 5. Photomicrograph of section from the spine with a typical actinomycotic colony.

In the abdominal cases 5 out of 23 recovered.

The spinal cases were not recorded separately. However, their possible recovery would be a part of the general healing process and the earlier its recognition the greater the possibility of a cure.

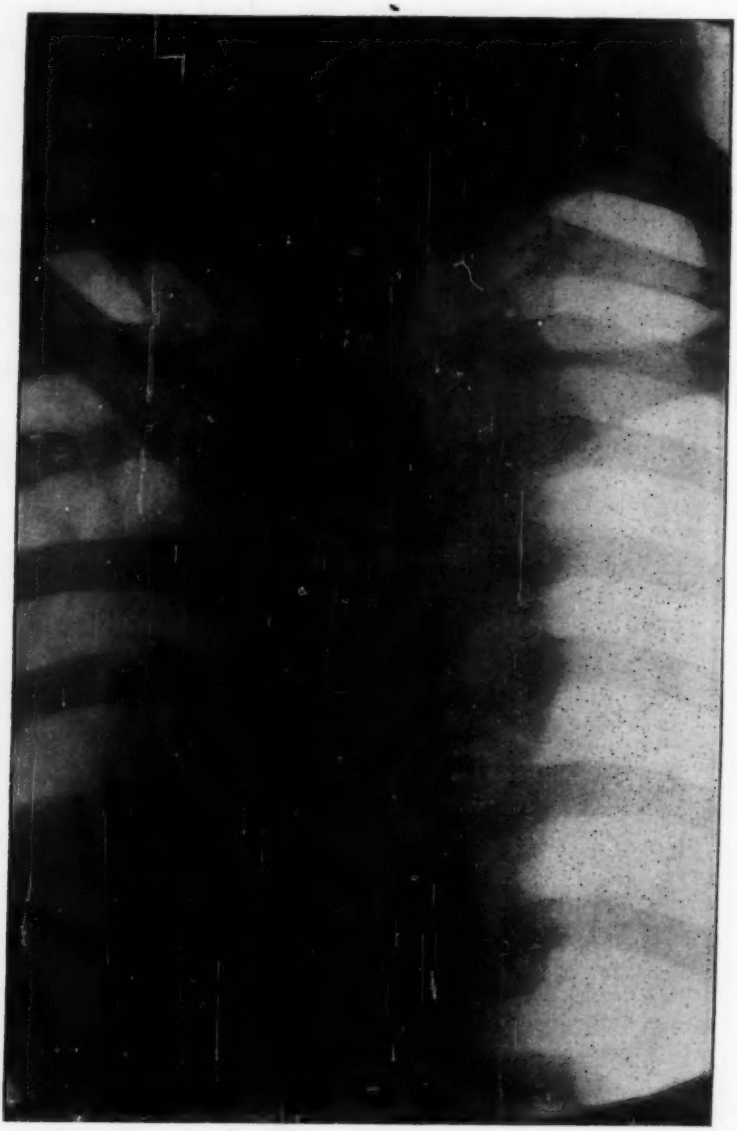

Figure 6. Blastomycosis of Spine. X-ray showing alteration of the body of the 4th thoracic vertebra with definite fracture of the neck of the right 4th rib.

BLASTOMYCOSIS.

The author's patient was a married man, 27 years old, who was first seen in June, 1918. At that time the following history was obtained: In December, 1916, patient first noticed distress from "gas in the stomach." He had incompletely recovered from a pneumonia of the previous winter. With the stomach trouble he had pain extending around the chest toward the back. Back now hurt severely most of the time. The patient was tall and pale. Back was rigid in lumbar region, tender on pressure to the left of the 10th dorsal vertebra. No kyphos.

X-ray showed very little bone change. There was a dense shadow opposite the 5th and 6th dorsal vertebrae that suggested an abscess. No lipping of the vertebrae. Diagnosis of tuberculosis of the spine was made and a brace

Figure 7. Gross specimen showing erosion of bodies of thoracic vertebrae with complete destruction of the pedicles of the 4th.

with recumbency was advised. This advice was followed, but in August the patient was brought to the Presbyterian Hospital, as he had not improved at home.

Here a thorough medical examination was made by a very competent internist, but nothing regarding the true nature of the condition was disclosed. On Nov. 4th, 1918, the following notation appears: "Has gradually grown worse. Complains of severe pains extending around the chest at the 4th rib. Now is completely paralyzed in motion and sensation in all parts below the navel. A recent x-ray shows the 4th dorsal vertebra mottled and partially

Figure 8. X-ray of specimen showing destruction of the necks of both 4th ribs and partial erosion of the body of the 4th thoracic vertebra. Part of the extensive destruction is due to the portion resected for study. There is little collapse of the vertebrae.

decalcified and the neck of the right rib fractured with the same structural appearance. (See Fig. 6.) Is constantly kept under morphine. Mind clear." With the change in the x-ray appearance the diagnosis was changed to malignancy, type unknown. Repeated examinations of sputum did not give a clue to the infectious agent.

Actinomycosis was considered because of previous sad experience, but there was no evidence of a primary focus; no sinuses or skin lesions.

The patient died on the 9th of December. At the post-mortem a burrowing abscess containing about one-half ounce of grayish pus was found extending along the left side of the 4th, 5th and 6th dorsal vertebrae, the 4th dorsal vertebra was extensively destroyed, and the right and left 4th ribs were fractured by disease of their necks. Pressure necrosis of the spinal cord was present at the level of the 4th thoracic vertebra. Firm adhesions bound the left lung to the spine in this region. Numerous hard nodules were scattered throughout portions of both lungs, which later proved to be blastomycotic.

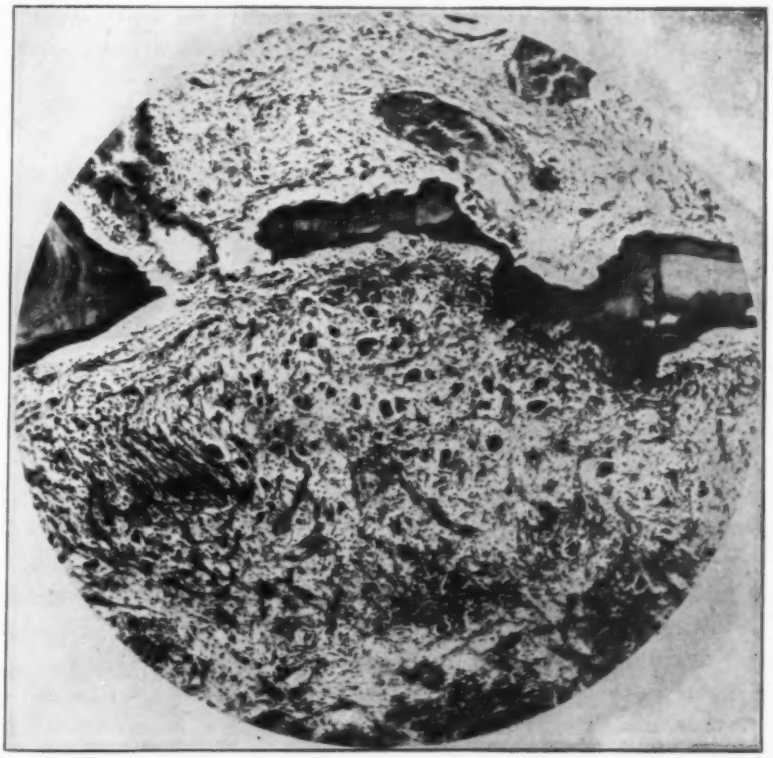

Figure 9. Photomicrograph of specimen taken from the spine showing invasion and lacunar absorption of bone. Numerous giant cells and fibroblasts are present.

The 4th to the 9th vertebrae were invaded by the infection.

The specimen was x-rayed to determine more detail of the process, and microscopic sections were made to show the method of attacking the bone. See Figures 7, 8, 9.

Following is the pathologist's report:

"There is an abscess about the bodies of the 3rd to the 7th thoracic spine, which extends laterally on to the anterior surfaces of the ribs and into the spinal canal, completely encircling this segment of the dura. The arch of the fourth thoracic vertebra has been destroyed, except for the spinous process, but the other arches show only slight erosion of the pedicles without involvement of laminæ or transverse processes. There is marked surface erosion of the bodies and intervertebral discs and of the anterior portion of the pedicles and the ribs which bordered on the abscess. None of the involved bodies are collapsed, and section of the 4th, which is the one most extensively eroded, shows that the involvement has been from without, as the interior is quite broken down. The first portion of either 4th rib is extensively eroded and destroyed for a distance of three quarters of an inch. The arches of the other vertebrae are little involved, except the pedicles, which show considerable surface erosion. There is considerable granulation tissue covering the eroded bony surfaces and filling much of the space between outer surface of dura and the walls of the surrounding vertebral canal. The bodies of the 4th to the 7th were removed and the dura opened from the front. There is direct extension of the inflammatory process through the dura on the anterior surface of the cord opposite the level of the 4th vertebra, forming a flattened mass about 1.5 cm. long and compressing the cord from the front and left side. The rest of the cord and meninges are free from inflammation. The roots of the nerves emerging in this vicinity run through inflammatory tissue about the meninges and arches. It is difficult to state in which vertebra the process began, but it was probably the 4th thoracic, inasmuch as its arch was so extensively destroyed and its body showed the greatest amount of superficial erosion." (See Figs. 7 and 8.)

Microscopic Findings: A section was taken through the body of the 4th dorsal vertebra, including a portion of the 3rd intervertebral disc. About the irregularly eroded surface of the body there is a layer of inflammatory tissue which extends to varying depths within the vertebra. The external portion of inflammatory tissue is composed largely of round and epithelioid cells with extensive areas of necrosis, while the deeper portions contain large numbers of giant cells and fibroblasts. The outer bony trabeculae show extensive lacunar absorption. The uninvolved bone marrow of the interior is slightly more hyperemic and fibrous than normal. The intervertebral cartilage is eroded by granulation tissue at its limits, but is unchanged in its

central portion. A few polymorphonuclear leukocytes are present in the more extensively degenerated portions of the inflammatory tissue. Blastomyces could not be definitely identified in the specimens stained with eosin and hematoxylin. (See Fig. 9.)

This was an occult case with the spinal, or orthopaedic, symptoms predominating and obscuring the pulmonary.

BLASTOMYCOSIS IN MAN.

Busse, in 1894, published his first account of a pyaemia caused by a yeast. Curtis, in 1896, published a complete study of a case in which myxoma-like tumors were caused by a yeast-like organism, the patient having come under his observation the year before. In both of these cases bone and other deep tissues were affected.

"To Gilchrist belongs the credit of having first observed and described a pure skin disease caused by a yeast-like fungus."—Ricketts.

This case had really been observed before Busse's report, but it was not until after the latter that the organisms were positively identified as blastomycetes. Dr. Irwin Smith, of Washington, D. C. applied to the organism the name "Blastomyces dermatitidis." Then rapidly followed reports of cases by our American physicians and pathologists, Wells, Hessler, Hyde, Hektoen, Bevan, Coats, Baldwin, Brayton, Ricketts, and others. An excellent résumé of the early history of the disease and its organism is to be found in the memorial volume, "Contributions to Medical Science"—Ricketts, University of Chicago Press, 1911. It was at first considered solely a skin affection in this country and in only one of the twenty-six cases collected by Ricketts was it found elsewhere and that was in the lungs.

The most comprehensive discussion of generalized blastomycosis by several authors is contained in the Archives for Internal Medicine, 1914, in which Stober presents 29 cases collected from the literature, with invasion of the spine in 6, in the serial numbers 7, 8, 18, 19, 23, and 28, this being their order of succession in the generalized group. He summarizes this group as follows: The bodies were affected in all these except 23, in which the laminae were primarily affected. In two the spinal cord was affected, cases 18 and 23. It is more rapid and painful than Pott's disease. The duration is from four months to two years. In the majority of cases infection occurred in the lungs. The mortality was 90%.

As I have records of but seven cases besides the one just reported, a brief résumé of this number is given.

Summary of cases.

No. 7, 1905. Eisendraht and Ormsby. Male, aged 23 years. Blastomyces were found in the sputum. Died later after developing a dorsal kyphos.

Autopsy by Dr. LeCount, from whom we quote, "Kyphos at 4th dorsal vertebra, abscess between the pleurae. The anterior surface of the 2nd dorsal vertebra is the seat of a shallow erosion occupying the entire surface. The anterior half of the body of the 3rd, the entire body of the 4th, and the posterior half of the body of the 5th dorsal vertebrae are absent. There are found only a few fragments of the 4th, namely, the spinous and the articular processes. The cartilages on either side of the 4th are absent.

No. 8, 1904. Bassoe, from Senn's service, Presbyterian Hospital, boy, aged 17. "Blastomycotic caries of the 4th and 5th lumbar vertebrae." Organism found in pus and in the sputum. This was the first spinal case demonstrated at autopsy.

No. 18. Oswald, Patient a man in Alexian Brothers Hospital. Autopsy by Dr. W. A. Evans, who reported "several vertebrae were practically destroyed, together with the cord."

No. 19. Krost, Stober, Moes, Iowa. Man, aged 42 years. Abscesses of the back "exposed the 7th and 11th ribs, and the 9th, 10th, 11th, and 12th thoracic, and the 1st lumbar vertebrae, the spine of the 9th being almost completely eroded, the others showing only slight involvement." Many abscesses were present elsewhere.

No. 23, 1907. Boughton and Clark, Service of Dr. Ryerson. Male, aged 21, at Cook County Hospital.

"A kyphos at the level of the 2nd dorsal vertebra was noticed at this time." Diagnosis of tuberculosis of the lungs and spine was made. Three weeks later the patient became totally paralyzed. Sensation was diminished in the legs but was never completely lost. The knee jerks were increased; ankle clonus and Babinski's sign also were present. The diagnosis was changed in the presence of cutaneous lesions, and the organisms were found in the sputum and in the pus. The kyphos became more marked and death ensued. The post mortem disclosed "Kyphosis of the last cervical and the first dorsal vertebrae. This was covered by a large abscess. Manipulation of the first dorsal spine elicited distinct crepitus. Examination of the spine incomplete and no other part found affected."

No. 28, 1909. Eisendraht and Boughton, Cook County Hospital. Service of Dr. Ormsby. Male, aged 19 years.

Generalized infection. At autopsy the right side of the body of the 4th lumbar vertebra was found somewhat roughened. Chiseling into it, an abscess cavity was encountered which occupied about one-third of the body. The 3rd and 5th vertebrae were normal.

In the preceding collection I am not able to distinguish the case of Irons and Graham in the Presbyterian Hospital in 1905, with autopsy by Dr. LeCount.

The patient was 47 years old. Besides many cutaneous lesions, the post mortem record includes a "Retropharyngeal abscess with erosion of the bodies of the 7th cervical to the 5th dorsal inclusive and the anterior surfaces of the vertebral extremities of the 2nd and the 5th ribs." No vertebral symtoms were present. Blastomyces were found in the sputum. This makes seven cases exclusive of the one reported by the author.

Montgomery, in 1917, made a very exhaustive review of all obtainable cases of generalized blastomycosis and collected 44 cases, among which 9 were given of the vertebrae. These doubtlessly contained the six cases reported by Stober and the case by Irons and Graham, but I am unable to trace the others as their sources were not given. The lungs were affected 42 times, spleen, 18; liver, 11; kidney, 12; other bones 16 times. His percentage of vertebral incidence was 20.4%, a very considerable proportion.

His article is the latest compilation and I have been unable to find any more spinal cases in the literature up to the present.

As in actinomycosis, so probably in blastomycosis, some spinal cases that do not come to autopsy are not recognized, but as the total number of generalized cases reported up to the time of Montgomery's compilation was but 44, and the reports of further cases have been very meagre since then, it is evident that not so many are overlooked, as must be the case in actinomycosis, even if not all are diagnosed before death.

Diagnosis.

In Eisendraht and Ormsby's case the patient died after developing a dorsal kyphos.

In the Boughton, Clark, Ryerson case the history distinctly states, "A kyphos at the level of the 3rd dorsal vertebra was noticed at this time." Later "the kyphos became more marked." This was accompanied by complete motor paralysis.

In the author's case there was no definite kyphos, as the patient lay on his back continually during latter part of his illness. With the evident destruction of the 4th thoracic vertebra it would doubtlessly have shown had the patient been set upright. This gives two cases with distinct spinal deformities and a third with potential deformity.

As stated in Stober's statistics and experienced in the author's case, continuous and severe pain is the rule. This is not long relieved by reclining or other orthopaedic measures for overcoming gravity and pressure. It is the pain of malignant disease.

The favorite site of attack is the bodies, whence it extends into the pedicles, laminae, transverse and spinous process, and on to the ribs, a picture practically unknown in tuberculosis.

The presence of spinal symptoms in a frank case of recognized blastomycosis should readily suggest the character of the spinal infection and lead to the use of similar diagnostic measures to those mentioned in actinomycosis.

The presence of spinal symptoms in a patient suffering from an undetermined generalized infection or rare skin lesions should lead to an investigation of the accessible lesions in an effort to solve the spinal one.

In the hidden case, like the author's, with no external or general lesions, except those in the lungs, just the possibility of blastomycosis should be kept in mind.

The x-ray will be an important factor in the diagnosis. Regarding the x-ray appearance, Potter says, "The primary constant finding in the active lesion in bone is that of a localized dissolution. So intense and well defined is this process that it results in the peculiar condition in which centers of completely dissolved bone lie immediately adjacent to spongy bone tissue entirely intact." The affected bones, however, do not show the same diffuse porosis and general decalification as in tuberculosis, but are more patchy in appearance." Sequestrated bone has not been observed radiographically except in the form of detached fragments of spongy material resembling the fringe lining a cavity."

Lesions of the spine show the same patchy appearances that are found in the short bones of the wrist. A marked destruction of the vertebral bodies may take place before a collapse of their substance occurs.

This description fits very well the appearance observed in actinomycosis of the spine, with multiple separate and confluent foci and little tendency to lose the general form of the bodies.

Treatment.

The orthopaedic treatment, as in actinomycosis, is likely to be futile, as the spinal infection is also a secondary one and the primary condition may be far advanced before the spine is invaded. Measures suggested for actinomycosis are indicated here, and similar general measures may be employed.

Prognosis.

As all the spinal cases reported have come to autopsy because of their infection, their mortality is 100%.

Here also, earlier recognition and the development of newer methods of treatment may eventually give a more hopeful outlook

SUMMARY.

It is thus evident that in dealing with actinomycosis and blastomycosis of the spine we are dealing with an extremely malignant condition, with all the dis-

tressing features incident thereto, and before which we are today practically powerless. Yet, as they are both infectious processes instead of biologic perversions, there is a reasonable hope that their baneful effects will eventually come more or less completely under our control.

Note.

In the immediate future we shall have to consider oidomycosis of the spine, as Dickson, of San Francisco, in 1915, reported one case in California in a Hindu laborer, 26 years old. The post-mortem revealed "marked destruction of the bodies of the lumbar vertebrae." The infecting organism was oidium coccidoides. A young man suffering from this disease in Chicago, imported from California, recently had his second foot amputated for this disease. The spine has so far apparently escaped.

TREATMENT OF OBSTETRIC BRACHIAL PARALYSIS WITH A REPORT OF FIFTY CASES*.

BY SAMUEL W. BOORSTEIN, M. D., F. A. C. S., NEW YORK CITY.

The great interest recently shown in obstetric paralysis is due to the excellent work of Sever[13, 14]. Before him, considerable work was done by Kenedy, Clarke, Taylor and Prout[6], Fairbank[8] and Platt[12], but the profession at large was somewhat indifferent to this malady. Ehrenfest[7] in his monograph on Birth Injuries puts this state of affairs in proper light by stating: "Exact information concerning this phenomenon (in the newborn) is deplorably defective on account of the evident lack of interest of the obstetrician in the problem, which indifference in turn prevents the orthopaedist from seeing these palsies in the very early stage."

The family physicians in general not only gave a poor prognosis to the unfortunate parents, but did not even take the trouble to submit the patient to a more thorough examination by those qualified to do so. They were uncertain as to the proper treatments and usually, on their own accord, ordered massage and exercises to be given by the parents, and added, perhaps, the ever-abused electrical treatments.

It was Taylor who aroused the interest of the profession to the proper etiology and the prospects of improvement following nerve suture. His advice has not been followed extensively because of the natural reluctance of the public to submit to operations, especially in the case of infants. Fairbank in England and Sever in this country have again aroused the profession. They have emphasized the improvement that we can obtain by orthopaedic treatment, and, as a result of that, these patients are brought at present to the men best qualified to treat such cases, viz., the orthopaedic surgeons. The large number treated by the orthopaedic surgeons at present, as for instance, the eight hundred cases of Sever, proves that these cases are prevalent but were never brought to the surgeon's attention.

The cause of future treatment may be influenced by the controversies occurring in the methods of observation and conclusions deduced. It is, therefore, of paramount importance to report the results, and where the opportunities offer themselves to help clear up the difficulties.

* From the First Surgical Division of Fordham Hospital, New York.

While the group here reported is small in comparison to the number of cases reported by Taylor[17] and Sever[13], I feel, however, that I am in a particularly favorable position to compare some of the different methods, for the reason that I had the good fortune to assist Dr. Taylor in doing nerve suture operations on some of the cases. Some of these cases were under my observation for considerable periods before and after the operation.

In the Fifteenth Report of Progress in Orthopaedic Surgery prepared by Dr. Osgood and his coworkers it is stated: "Taylor still believes in operation on the brachial plexus in most cases of obstetric paralysis, since recoveries, as a whole, have been so unsatisfactory. He thinks the best time for this operation is at about three months." Some of Taylor's deductions have been misunderstood, while Taylor himself has changed the time of operation. It may, therefore, interest the members of this Association to get a report of some of the conclusions based on this work. I do not believe I shall lay myself open to criticism as being biased. In my training I am naturally inclined to orthopaedic methods, but medical interest requires that Dr. Taylor's advice be better understood. I am almost sure that in suitable cases these methods will then be followed. Perhaps more suitable cases will then be found to be operated on.

ETIOLOGY.

Here is not the place to discuss the etiology in detail, but in order to understand the work better, I have to remind you that it has been proven beyond any trace of doubt that the correct theory is the "traction theory," i. e., the damage is done by stretching of nerves of the brachial plexus by forcible separation of the head from one shoulder during delivery, or by direct traction on the arm (stretching, of course, may often result in complete tear of the nerve fibers). The work of Taylor[17,18], Sever[13,14], Fairbank[9] and Platt[12] has established this theory. In a few of the cases reported in a previous paper and in some additional cases reported below the damage to the nerves was distinctly found.

There is no need to mention the fallacious theory of T. T. Thomas[21,22] of congenital subluxation, as well as the theory of Weil[7] that often there is a truly congenital defect of development of the plexus as the result of continued mal attitude of the shoulders during intra-uterine life.

Fairbank[9] summarizes the conclusions about the theories briefly as follows:

"Although the occasional presence of definite adhesions in the joint in young infants suffering from birth palsy strongly suggests damage to the joint in these particular cases, I believe the traction theory best explains

the condition present in the vast majority of the cases and that the subluxation of the shoulder joint develops gradually and as a direct result of the paralysis. I hold this view for the following reasons:

"1. Tenderness and thickening over the plexus in the neck has been noted soon after birth in some cases.

"2. The almost constant finding of definite injury, sometimes amounting to complete rupture, of one or more nerve bundles of the plexus during operation. Those most likely to be damaged by separation of head and shoulder, viz.; fifth and sixth cervical, are the ones most found to be paralyzed.

"3. Experimental evidence that traction can produce tearing of these nerves, and that damage to the shoulder joint is extremely difficult to produce, fracture of the humerus or separation of its upper epiphysis occuring first. (Clarke, Taylor and Prout, Thomas and Sever, T. T. Thomas and Stone.)

"4. Taylor actually felt the plexus tear during delivery of a child, and the lesion was proved post mortem.

"5. Subluxation of the joint is rarely seen at birth, but its gradual development and fixation can be traced through cases of increasing age, the subluxation at first being reducible and becoming irreducible later."

About the mechanism of the force producing the injury at birth I will quote Ehrenfest[7]:

"1. The plexus is occasionally injured by the forceps and (2) possibly more often traumatized by a finger during improperly executed traction in the delivery of the aftercoming head. (3) Cervical nerve fibers under special mechanical conditions are injured by compression between clavicle and underlying bone structures, both in vertex and breech labors, and (4) probably less often are actually lacerated by excessive traction."

About the absence of congenital dislocation of the shoulder, Taylor[18] proved in his recent article on "So Called Congenital Dislocation of the Shoulder, Posterior Subluxation" that (1) there is no case on record where in a birth palsy case a posterior subluxation of the shoulder has been found at birth.

(2) No dislocation present up to six weeks of age. The dislocation at that time is sequel to the paralysis.

(3) The posterior dislocation is a sequel to the unbalanced paralysis of the shoulder muscles, and may be prevented in most cases by proper treatment. (Orthopaedic.)

(4) The external rotators (posterior muscles) suffer the most complete paralysis, and are continuously overstretched by the internal rotators, which

are usually not completely paralyzed and eventually develop organic contracture, with the result that the head of the humerus is gradually displaced backward.

SYMPTOMS.

The symptoms of this disease are well known and we will only recall to your mind the deformities present.

In the upper arm type: The arm hangs vertically in full internal rotation and adducted, and with the forearm pronated and the palm looking outwards and the fingers usually clenched, the so-called "policeman's tip position." The muscles chiefly affected: Supraspinatus and infraspinatus, deltoid, biceps, coracobrachialis, brachialis anticus, supinator longus and brevis and teres minor, i.e., the abductors and external rotators of the shoulder, flexors of elbow, and supinators of the forearm, and sometimes the radial extensors of the wrist. The serratus magnus is not uncommonly affected to a considerable extent. The injury to the plexus is located at about the junction of the fifth and sixth cervical nerve roots, just about the points of origin of the suprascapular nerve (Erb's point).

In the whole arm type (called by some lower arm type) all these conditions are found, besides the additional ones due to the paralytic conditions of the lower arm and hand, resulting generally in a useless dangle arm. There is usually wrist drop, paralysis of the flexors and extensors of the wrist and fingers, associated with paralysis and atrophy of the intrinsic muscles of the hand.

The injuries are mainly to the whole of the plexus, or at least the seventh and eighth cervical and the first dorsal roots.

There are rare cases involving the lower roots only, without the upper, (Klumpke's paralysis).

TREATMENT.

Prevention.—As most of the cases are due to delivery, Ehrenfest gives a proper warning to the obstetricians, advising special care in the application of forceps, and emphasizes the methods of managing the shoulders as follows: "In Mauricean-Smellie maneuver, the tips of index and middle fingers should be forked above the shoulders, not on the sides of the neck, but on the sternum of the infant." He advises that obstetricians with short fingers should keep the ends of these two fingers in extension and not flexed, as would be their more natural attitude in the attempt to pull on the shoulders. If severe traction is necessary, it should be made along the long axis of the child and never against or on the head in lateral flexion.

EARLY TREATMENT.

If the child is brought early to the orthopaedic surgeon, one of three methods is usually followed: (1) Retention in braces or a plaster cast followed by careful exercises. (2) Careful exercises (muscle training) alone without some retention apparatus. (3) Operative, viz., end to end suture of the injured nerves.

(1) Retention in plaster cast or braces.—In order to prevent contraction of unparalyzed muscles, it seems best to put the arm at rest in such a position that the stronger muscles can not contract. The arm is, therefore, put up in right angle abduction and full external rotation of the shoulder, the elbow is flexed at a right angle, forearm in full supination and, if necessary, dorsiflexion of the wrist. I am accustomed to leave the first plaster undisturbed for two or three weeks. Then the arm is taken down twice daily for massage and exercises. The plaster is made for a removable one and reapplied after the exercises. If the arm is kept in the support between massage and gymnastic treatments, one obtains a better subsequent position of the arm. It also takes the drag off the paralyzed shoulder muscles, particularly the deltoid, allowing them to regain their strength more quickly, and prevents subsequent shoulder deformity, such as posterior dislocation and acromion hooking and overgrowth. As the child improves, the plaster is left off gradually. Fairbank and Platt are consistent in using immobilization and retention. Platt even says, "I have little doubt that if this were adopted in every case there would be few cases which show no recovery of the paralytic phenomena, and no case would develop the internal rotation, contracture and posterior subluxation of the shoulder joint."

Sever[13,14] in his early articles strongly urged this method but in a paper recently delivered before the orthopaedic section of the New York Academy of Medicine, he said that he does not put up the affected limb in plaster or braces but depends entirely on proper exercises. The reason given by him is that the child forgets the use of the hand.

My experience has been the same as Fairbank's[9]; that the use of the support is of distinctly more advantage than if left off. Several cases of my series have convinced me of the advisability of proper and early support. I remember a number of patients who had no deformity when in the support but whose parents took off the support too early and, while apparently carrying out the exercises regularly, the deformity returned, or rather has not entirely been avoided. Of course, one has to watch for stiffness following the long immobilization, (See Case 29) but watching against deformity is the supreme duty of the orthopaedic surgeon and he can easily guard against adhesions. However, my experience is not as extensive as that of Dr. Sever.

About exercises: Those advocated by J. J. Thomas[19] of Boston seem to answer the purpose well. Lately at the Children's Hospital of Boston, Dr. Sever added the novelty of rhymes to the exercises, thus making it perhaps interesting for the infants. It is a form of occupational therapy that is worth while using. (We may have to give music lessons to our masseuses to have them administer the exercises.)

I also made use of some of the exercises advocated by Steindler[15] in his article "Muscle Educational Treatment and Results in Orthopaedic Work on Upper Extremity."

One must emphasize the fact that exercises or muscle training should be kept up for a very long time, perhaps till the child is ten years of age.

EARLY NERVE OPERATION.

Taylor's Method of Nerve Suture.—Taylor, following his careful observation with Clarke and Prout, advised early repair of nerve injury. He published many articles and showed his results. Some surgeons still doubt whether it is advisable to operate. They maintain that the result is not better than without the operation. Sever emphatically denies the advisability of that operation.

Fairbank[9], on the contrary, says:

"At what age should exploration upon the plexus be undertaken? If a case has been treated from the first, and after three months there is no sign of recovery by physical examination and electrical tests under an anaesthetic, I think operation is advisable. Many surgeons consider three months too early. The age favored by writers on this subject varies from two to twelve months. I am convinced that, in most, recovery is well advanced by the age of three months, and I think that rarely are the recognizable signs of recovery delayed beyond this period."

Taylor[17] in his latest article states: "The small minority of cases that do recover spontaneously are almost completely well at the end of three months. In cases which are obviously mild at the start one may expect a spontaneous recovery which will be nearly complete by the end of three months. Therefore operation is not indicated. In the more serious group in which almost the entire musculature of the extremity is primarily paralyzed and the lower roots show no tendency to spontaneous recovery in the first few days, it is practically certain that a permanent lesion has occurred, at least in the upper one or two roots, and early operation is indicated. Naturally, in the still severer types of injury, early operation is indicated without question. In the border line cases, operation is more debatable and

one must choose between early exploration and delay for three months to see what degree of spontaneous recovery will ensue. . . In all cases, whether operation is to be considered or not, the extremity should receive systematic attention. It is of primary importance to retain the extremity in a position which relaxes the paralyzed groups of muscles. . . This position may be retained by use of a brace such as is used by orthopaedic surgeons in deltoid paralysis. . . "

In a personal communication, Taylor gave me a short résumé of his views about the advisability of operating on these cases. I am quoting him exactly.

"Inasmuch as deformities can be prevented by proper postural treatment, and inasmuch as nerves will regenerate even though many months have passed since injury, one may wait safely for a considerable period of time, provided correct treatment is followed during that interval. If sufficient recovery has occurred during the first three months to justify the hope of almost complete spontaneous recovery, then it is legitimate to follow the case along with physical therapy. If, on the other hand, improvement at three months has been unsatisfactory, then, other things being equal, it is wise to do an exploration of the plexus. If there is damage which would not have recovered spontaneously, then the lesion can be repaired at once. If, by chance, the plexus is found not so involved as to demand surgical repair, the wound, which is practically only a skin incision, can be closed and the child's risk has been practically nothing. The advantage of this method is that without material risk one knows early in the case just what he is dealing with and if surgical repair is necessary it is done at the time which gives the greatest promise of favorable results."

The disadvantages of operation in very early infancy lie in the very small field and small nerves which make the technical part of the suture more difficult. On the other hand, the dissection is easier because the cicatricial tissue has not become so dense.

Are the results of operation better than these treated by orthopaedic methods alone? Cases 3, 23, 25 of my group, as well as other cases, prove that the operation is of distinct value if performed properly. One must, however, remember that the after treatments are of great importance. The operation is often discredited because the very severe cases showed no improvement at all.

When one watches the child from the start so that the deformities are prevented, the results following the operation are, of course, better. It is thus of paramount importance to guard against deformities, and, if present, to correct them by operative means before doing a nerve suture.

Method of Taylor's operation: "Oblique incision at the base of the neck from the posterior edge of insertion of sterno-cleido mastoid through skin, platysma and the underlying fat pad. When these are retracted the damaged nerves and adherent cicatrix are exposed. The various nerves are then dissected out and such repair work done as is found necessary."

LATE TREATMENT.

Correction of Deformities.—The most prominent deformity is at the shoulder, giving it adduction and internal rotation. If child is seen when the deformity is also present, it could be operated on by Sever's method of tenotomy of the contracted muscles.

When there is a hooking of the coracoid process, this could be corrected by a subperiosteal osteotomy. The acromion process often needs an osteotomy.

There is one deformity which is very persistent and that is the pronation of the forearm. For some reason the full supination is not attained. I have tried in many ways to prevent that but have not succeeded in all cases. In some I was fortunate enough to regain full power. This deformity can be corrected later on by an open tenotomy of the pronator radii teres.

Fig. 1.—Case 1.—Herbert A., Dec. 27, 1922—Showing extent of abduction of right arm. The elbow was kept in flexed position thus giving the impression that the arm is shorter. Note that there is no contraction of pectoralis major.

Fig. 2.—Case 1.—Herbert A., Dec. 27, 1922—Showing good power to rotate outward. This photograph shows that there is no shortening of the arm. Note the good muscular development and the excellent position of the wrist.

Fig. 3.—Case 1.—Herbert A., Dec. 27, 1922—Showing the extent of supination possible in the right hand.

Tubby suggests transforming the pronator radii teres into a supinator as follows: The pronator radii teres and flexor carpi radialis are defined and the tendon of the latter severed one and one half inches above the wrist. The pronator radii teres is put at full stretch and is joined to the proximal end of the flexor carpi radialis as low down as possible. The conjoined tendon is then pulled through the interosseous membrane, carried round the back of the radius and inserted on the outer side. A modification lately made by Tubby consists in a section at the same time of the interosseous membrane through its entire length. Sir Robert Jones is content to insert the pronator radii teres into the tendons of the extensor carpi radialis longus and brevis in order to destroy the power of pronation and strengthen dorsiflexion and correct ulnar deflection. One may transplant the muscle into the dorsal aspect of the radius.

If there is some rotation of the radius or ulna, an osteotomy has to be done.

Among the other operations used, one has to consider the stretching of the

Fig. 4.—Case 23.—Donald McC., Aug. 15, 1920—Before Treatment:—showing the typical position of adduction and inward rotation of the right arm. (Front View.)

Fig. 5.—Case 23.—Donald McC., Aug. 15, 1920—Before Treatment:—showing the typical "Policeman's tip position." (Back View.)

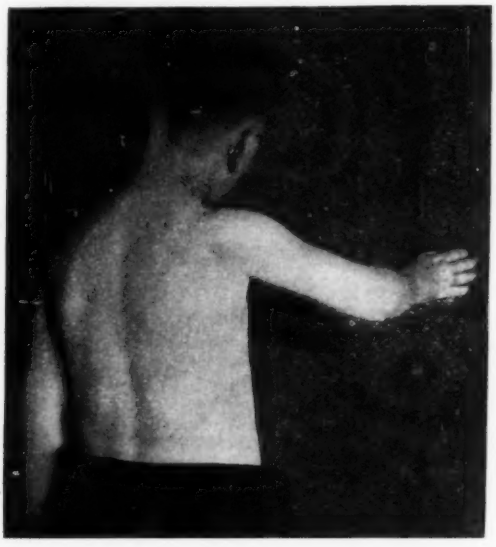

Fig. 6.—Case 23.—Donald McC., Aug. 15, 1920—Before Treatment:—showing power of abduction when the hand is supported on the wall.

Fig. 7.—Case 23.—Donald McC., Dec. 27, 1922—After Operation and Treatment:—showing power of abduction.

shoulder or elbow joint under deep anaesthesia and immobilization, but it is doubtful whether one obtains the desired results.

Report of a few cases to demonstrate certain features in the treatment.

Case No. 23.—Donald McC., male, age 8 years when first seen. History.—Child is the sixth in the family, instrumental delivery. Immediately after birth complete paralysis of right arm and forearm was noticed, with evidences of local trauma. Practically nothing was done for the child till seen by me on Aug. 12, 1920.

Physical Examination showed a well nourished and robust child. Right upper extremity held adducted and internally rotated with the elbow flexed to an angle of 160 degrees. Shoulder could not be abducted more than an angle of 5 degrees when he had to use the scapula. When patient lay on back, could abduct shoulder to an angle of 75 degrees. Outward rotation—markedly limited. Elbow flexed at an angle of 140 degrees. Can be flexed to an angle of 90 degrees. Forearm—pronated and could not be supinated. Wrist motion—fair. Finger motion—almost nil. Motor power of hand—right, 5 lbs.; left, 22 lbs. Slight atrophy of arm and forearm muscles. There was some asymmetry of the face. (Fig. 4, 5, 6.)

One can thus see that the nerves involved were probably CV, CVI, CVII, CVIII and DI.

Treatment.—Brace applied and massage and careful exercises begun. The boy is very intelligent and coöperated in every way. This course was followed for three months with very little improvement.

Patient was admitted to the First Surgical Division of Fordham Hospital and operated on by Dr. A. S. Taylor and myself on October 29, 1920. At the operation Sever's tenotomy was done, cutting only the pectoralis major. The shoulder was then released. There was hooking of the coracoid process and this was removed subperiosteally. The plexus was then exposed and the following condition found: fifth cervical and sixth cervical were torn off at the lower end of their junction, seventh cervical was torn off almost completely just where it inserted into the plexus, eighth cervical and first dorsal were not damaged but surrounded by heavy scar tissue.

Operation.—The distal ends of the nerves (fifth, sixth, and seventh cervical) dissected and end to end sutured with chromic cat gut. The scar

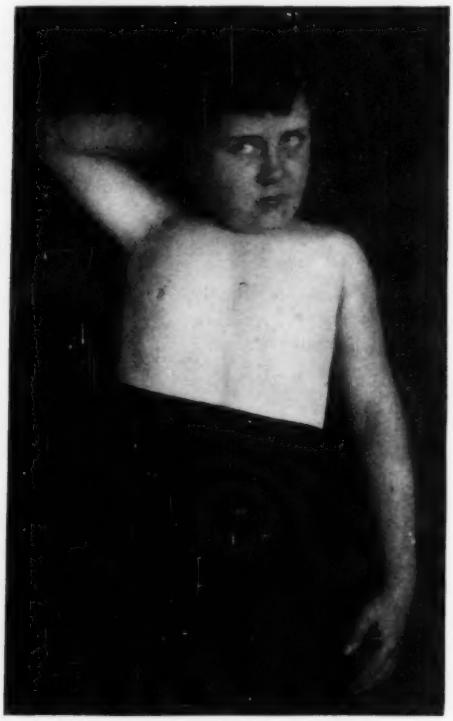

Fig. 8.—Case 23.—Donald McC., Dec. 27, 1922—After Operation and Treatments:—showing power of abduction when the elbow is flexed. Note ability to rotate arm outward.

Fig. 9.—Case 23.—Donald McC., Dec. 27, 1922—After Operation and Treatment:—showing power of supination of forearm.

tissue surrounding the eighth cervical and first dorsal removed and dissected freely the nerves.

After Treatments.—The hand was put back on the brace but the abduction was increased. Wound healed by first intention.

Nov. 20, 1920.—Began massage and exercises.

June, 1921.—Examination showed marked improvement. Brace discontinued.

Present Status (January 15, 1923).—(Which is the same as one year ago.) Patient can raise the shoulder to an angle of 110 degrees even when standing. If he desires to abduct the shoulder farther, he has to flex the elbow (showing therefore that there is contraction of biceps). Rotation outward—good. Extension of elbow—permitted to an angle of 120 degrees. Supination—limited. Wrist is slightly hyperextended. Finger motion—very much improved. (Fig. 7, 8, 9, 10).

Comment.—This patient illustrates that there was at birth distinct tear of 5th, 6th and 7th cervical and probably a tear of sheath of 8th cervical and 1st dorsal. He received orthopaedic treatment for a while but had not

improved enough. Since the nerve operation, the improvement has been marked. Would it not be better to operate at an earlier age than eight years?

One cannot attribute the entire improvement to the tenotomy, as the muscles supplied by the 7th and 8th cervical and 1st dorsal have shown marked improvement. The improvement in the deltoid is also marked.

January 19, 1923.—Patient was operated on by Dr. Taylor and myself at Fordham Hospital. An open tenotomy of the pronator radii teres was done. Forearm put in supination.

Case No. 25.—John S., male, age 6, when he came under my observation on November 11, 1920. No instrumental delivery. Complete paralysis of both upper extremities (whole). When the child was eighteen months old, a plexus operation on the right side was performed by a neurological surgeon. On June 4, 1921 a second operation was performed on the same side by the same surgeon. No after treatment was carried out. The result was nil. That discouraged the mother somewhat and she refused to have another

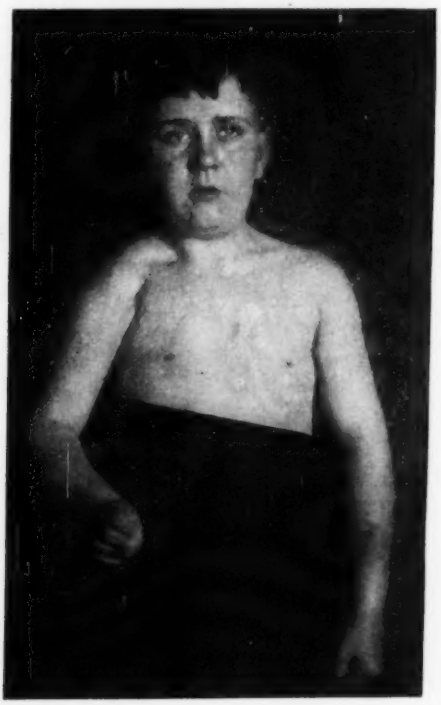

Fig. 10.—Case 23.—Donald McC., Dec. 27, 1922—After Operation and Treatment:—showing power in closing the fingers.

Fig. 11.—Case 25.—John S., Nov. 23, 1920—Before Treatment:—Note the position of both hands and the deformities.

operation on the left side, but used massage and exercises, with no improvement.

Patient examined by Dr. R. Sayre and myself on Nov. 11, 1920. Physical examination showed: Right hand—marked wrist drop, very little power to flex the fingers. Forearm kept pronated and could not be supinated. Elbow—extended, could not be flexed (due to a fracture of humerus). The head of the humerus was found anteriorly and an interval of ¼ inch present between head of humerus and acromion process. No power in the deltoid, internal or external rotators. Slight power in the pectoralis major (as tested when child bends forward permitting the arms to drop). Marked wasting of the muscles of arm and forearm.

Left hand—wrist hyperextended. Very little power in the flexors of the fingers. Some power in the extensors of the fingers. Elbow in position of flexion at right angle and could not be extended. Could flex the elbow so that the forearm touched the arm throughout its entire extent. Forearm—pronated and could not be supinated. Shoulder—Head of humerus dislocated backward. No interval between head of humerus and coracoid process. Shoulder rotated inward. Patient could raise shoulder slightly (to an angle of 20 degrees) could not rotate it outward. Some power in the pectoralis

Fig. 12.—Case 25.—John S., Nov. 18, 1922—After Operation and Treatment:—Note ability to raise the left shoulder. The right hand was resting on a support.

Fig. 13.—Case 25.—John S., Nov. 18, 1922—After Operation and Treatment:—showing power of abduction in right arm and power of flexion in left elbow. Note hyperextension of wrist.

Fig. 14.—Case 25.—John S., Nov. 18, 1922—After Operation and Treatment:—showing power of extension of left elbow. The deformity in the arm is due to a fracture of humerus.

major (Fig. 11).

Treatment.—A double deltoid brace in the usual position applied and massage and regular muscle training ordered.

This treatment was faithfully continued till January, 1922, when it was decided to operate. The physical examination showed some improvement in both shoulders, particularly the left, but the improvement was not enough to permit him to use them to an appreciable extent. We believed that he had all the chances with the conservative treatment and therefore decided to operate.

He was operated on at the First Surgical Division of Fordham Hospital by Dr. A. S. Taylor and myself on Jan. 20, 1922.

At the operation the following was found: fifth cervical root torn apart with the two ends connected by scar tissue, 6th, 7th, and 8th cervical seemed to be in good condition. The 1st dorsal absent. A larger incision was made to find the peripheral end of the 1st dorsal but could not be found.

Treatment—The damaged portion of the 5th cervical was resected about one cm. and an end-to-end suture of chromic catgut passed through the good bundles and tied. Braces reapplied. After treatment carefully carried out.

He improved considerably. In June, 1922, he sustained a fracture of middle of left humerus which healed in time, though somewhat delayed.

Present examination, January, 1923, shows: *Left shoulder* when sitting—can raise to normal extent even without the brace; rotation outward better. Elbow flexed to an angle of 90 degrees and can be extended to an angle of 115 degrees; can be flexed to an angle of 45 degrees. Good power in the biceps. Forearm is supinated. Wrist is hyperextended. When the wrist is supported and kept in straight position can use the fingers fairly well even to feed himself. *Right shoulder*—Slight improvement but not as much as the left; can abduct the arm only to an angle of 10 degrees. Rotation—nil. Elbow is in position of extension. No power in the biceps. There is wrist drop. Forearm is pronated and marked deformity of radius present. (Fig. 12, 13 and 14.)

Operation on January 19, 1923 by Dr. Taylor and myself in Fordham Hospital. The right plexus was exposed and it was found that all fibers of the 5th, 6th, 7th and 8th cervical were of normal size and showed no evidence of tear. It is therefore evident that there was an avulsion of the nerves from the cord. An osteotomy was also done on the right radius, and forearm put in supination.

Comment.—This patient had a distinct injury to the nerves. The result of the first operation was not satisfactory, either through improper operation or through neglect of after treatment. He received conservative treatment for more than one year with very slight improvement. Following the plexus operation on the left side, however, with the same treatment, the improvement was marked. This was also a very bad case of whole arm paralysis in a child seven years of age. How much better would it have been to operate early, though some claim that there is no use in operating on severe cases.

Case No. 20.—Charles D., male, age 7. Came under my observation on May 8, 1920. Paralysis of right side (upper type) with marked contraction of the pectoralis major and teres major; can not abduct voluntarily the shoulder more than an angle of 25 degrees.

He was operated on May 19, 1920, on the First Surgical Division of Fordham Hospital by Dr. Taylor and myself. Sever's operation was done (tenotomy of the pectoralis major and subscapularis). The plexus was then exposed, and only two small neuromata over 5th and 6th cervical roots found; freed the fascia but no nerve suture performed. There was, therefore, distinct evidence of nerve injury.

Result.—Child has perfect use of the entire upper extremity. (Fig. 15 and 16.)

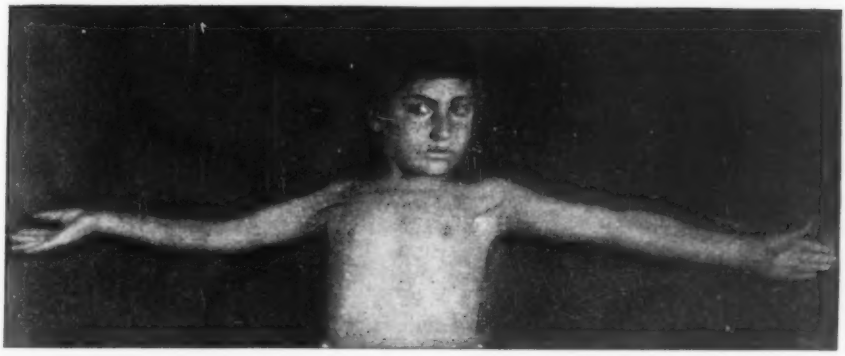

Fig. 15.—Case 20.—Charles D., Dec. 16, 1922—After Operation and Treatment:—showing good power of rotation outward and supination.

Fig. 16.—Case 20.—Charles D., Dec. 16, 1922—Showing good power of abduction after the operation and treatment.

Comment.—This case demonstrates the nerve injury but proves that the lack of motion was due to contraction of the pectoralis major and subscapularis. Had the child been treated properly from the beginning with orthopaedic measures, he would have made a perfect recovery, as the nerve regeneration was good.

Case No. 3.—William B., (This case was reported in my previous article from which I quote); male, came under my observation when six months old with right side whole arm paralysis. Treated by me for a short time by a brace, massage and exercises. Very little improvement resulted. Operated on by Dr. Taylor and myself at Fordham Hospital. Sever's operation performed, cutting the pectoralis major, teres major, and subscapularis. The brachial plexus was then exposed and the fifth and sixth roots were found seriously damaged, forming two masses connected by a narrow isthmus of connective tissue. The scar tissue was excised for a distance of 3 cm. until good nerve bundles were found. An end-to-end anastomosis was then done. Brace reapplied and after-treatment carefully carried out. The child made a perfect recovery with the exception of supination of forearm. He can not supinate it freely.

Comment.—This case demonstrates that the plexus was injuried extensively and would not have recovered by conservative treatment. Shows also the excellent result that one obtains from combination of Sever's and Taylor's operation at one sitting.

Case No. 1.—(Reported before, but case has been kept under observation since that time). Herbert A., (Referred by Dr. Ballin) male, age 3 weeks when brought to me in 1918 with right sided whole arm paralysis. Treated with a plaster cast. Made a complete recovery in one and one half years, with the exception of supination. Though he cannot supinate the forearm completely, he can use the hand to eat and write. (Fig. 1, 2, and 3.)

Comment.—This patient demonstrates that with proper orthopaedic treatment, viz., support and muscle training, one can obtain perfect result, with the exception of supination. I have had several cases in which in spite of excellent orthopaedic treatment, the full supination could never be obtained. This is probably due to inability to hold the forearm in good position. I have tried different devices in the plaster and the brace but so far have not perfected a method to prevent the deformity.

Case No. 32.—Sydney S., male, brought to me at the age of three weeks with upper arm paralysis. There was marked tenderness at the shoulder. A plaster cast was applied, which was changed after three months to a brace. Patient made a good recovery, but there were adhesions at the shoulder joint, thus giving him a prominent scapula. The adhesions had slowly to be broken up and then the full use was obtained.

Comment.—This case demonstrates that adhesions may occur in cases due to injury of the capsule. This can easily be foretold by the marked tenderness directly at the joint. The adhesions must be guarded against. I have had a few cases similar to this.

Case No. 27.—Alvin A., (Referred by Dr. Rubinstein) male, whole arm paralysis. Distinct history of impacted shoulder. Was seen by me at the age of four weeks. Put in a plaster cast for two and a half weeks; then instituted the usual treatment. After treating the child for two months found that the child kept the arm continuously in an abducted position (about 90 degrees with torso), due to adhesions formed. It took about four months before the shoulder was loose. Child made a perfect recovery.

Comment.—The adhesions in this case were evidently due to the injury of the capsule at birth and to the fact that I kept it in the abducted position for a long time to prevent stretching of the muscles. This case is reported as a warning to guard against adhesions where there is evidence of injury to the capsule. It also shows the inadvisability of keeping such cases in the abducted position without bringing the arm to adduction more frequently after the first two weeks.

Case No. 29.—Martin F., (Referred by Dr. Lenetzka) male, brought to me at the age of two and a half months with the typical deformities. Child received up to that time electricity and massage.

Arm was put in plaster cast, which was kept on for three weeks, then changed for a brace. Massage and exercises instituted. After receiving treatment for three months, the deformities were corrected and patient had fair use of the limb. The parents then discontinued the brace of their own accord but continued the exercises used by me. The mother was an intelligent woman and carried out the exercises regularly. I have not seen the child for a full year. When seen by me again, I found exactly the same deformities as at the first examination, though the child had fair use of the muscles.

Comment.—This case brings out the fact that the plaster or brace will correct the deformity in early stages; but deformity will return if the support is not continued long enough. If no brace has been used from the beginning, it stands to reason that the deformities will develop in spite of proper exercises. I have had a few similar cases where I had prevented the deformities when I had a chance to see these children early, but if the plaster or brace was discontinued too soon, either through my own order or through the parents' neglect, some deformity, though not so severe as in the usual run of cases, resulted.

Case No. 17.—Robert C., (Referred by Dr. Clurman) male, age 7 weeks when he came under my observation. Whole arm paralysis of the right upper extremity. Deformities—evidence of hematoma and adhesions of the right sternocleido mastoid, shoulder abducted and internally rotated. There was distinct laxity of the shoulder joint. Dislocation of head backward. Elbow joint extended. Forearm pronated. Some power in the fingers.

A plaster cast applied and left on for three weeks, then treatment instituted. Child made a good recovery in one year. The only deficiency left is inability to supinate freely.

Comment.—This was a case where I suspected that a nerve operation would be necessary. However, with the proper treatment the result was very good.

CONCLUSIONS.

1. Obstetric brachial paralysis should be treated by the orthopaedic surgeon as early as possible.

2. If treated early and properly, one may expect in the mild cases a good recovery in three or four months.

3. The more severe cases will require about six or seven months for a complete recovery.

4. Nerve operations are indicated if no improvement results in four months.

5. If sufficient improvement is noticed in four months, one may wait for four months more.

6. The shoulder should be put immediately in a splint or brace to prevent stretching of the paralyzed muscles and contraction of the unopposed muscles.

7. The support must be kept up for a very long time, for about eight to nine months, as deformities may occur.

8. Adhesions may occur due to slight injuries of the capsule, but these can be prevented.

9. The only deformity that it is hard to prevent is the pronation of the forearm.

10. The posterior dislocation is a sequel to the unbalanced paralysis of the shoulder muscles and may be prevented in most cases by proper orthopaedic methods.

11. The obstetricians can prevent the condition in many cases by proper management of the shoulder.

12. Taylor's procedure seems to be the most suitable for the nerve operations.

13. After-treatment must be carefully carried out after Taylor's operation.

14. Sever's operation is the best for correction of the shoulder deformities.

15. Hooking of the coracoid process should be corrected by a subperiosteal resection.

16. Pronation should be corrected by a tenotomy of the pronator radii teres. One may also transplant that muscle to use it as a supinator.

I wish to thank Dr. Alexander Nicoll, the Surgical Director of the First Surgical Division of Fordham Hospital, for his esteemed cooperation; and Dr. A. S. Taylor for his kind assistance and for personal help in this work.

TABLE NO. 1

Analysis of the fifty patients (53 cases)

Boys	29
Girls	21
Right arm affected	32
Left arm affected	15
Both arms	3
Upper arm type	23
Lower arm type	24
Both upper arm type	1
Both lower arm type	2
Total	50
History of normal delivery	12
History of difficult labor	15
History of forceps	18
Unknown	5
Total	50
Head Presentation	43
Breech Presentation	7
Total	50

TABLE NO. 2

Results of Treatments

No. patients who had no treatment before coming to me	23
No. patients who received improper treatment	6
No. patients who received incomplete orthopaedic treatment	9
No. patients who received proper orthopaedic treatment	12

TABLE NO. 3

Results in Relation to Deformities

	mark. def.	mod. def.	slight	none
1. No treatment before coming	8	9	5	
2. Improper treatment	3	0	2	
3. Incomplete orthopaedic treatment	2	3	4	
4. Proper orthopaedic treatment		1	4	

TABLE NO. 4

Results of Cases Treated by Writer*
Of the fifty cases only 21 submitted to real treatment

Perfect Result	(95 plus)	9
Good Result	(80 ")	9
Fair Result	(60-70)	1
Poor		none
Unknown		2

* Results of proper orthopaedic treatment are based on a percentage basis giving Function 75%, contour and shape—25%.

TABLE NO. 5

Treatments used:

1. Plaster, 13.
2. Braces, 3.
3. Operation—
   - (a) Taylor's (performed by some other surgeon with complete failure) 3
   - (b) Taylor's operation performed by Taylor 2
   - (c) Sever's alone 1
   - (d) Sever's and Taylor's 4
   - (e) Stretching 1
   - (f) Tenotomy of pronator radii teres 1

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REPORT OF UNUSUAL GAS INFECTION, WITH COMPOUND FRACTURE AND BRIDGING OF NEW BONE WITHOUT BONE TRANSPLANT

LOUIS A. O. GODDU, M. D., BOSTON, MASS.

Patient, a young man nineteen years of age, had his left arm and right hand mangled in a rope machine, March 21, 1921. Was admitted to local hospital and attended by physician who made repair of the lacerated area under complete anaesthesia. Remained twenty-four hours in the hospital, and then was referred to the writer.

He presented himself in a very poor condition, temperature 103½, weak, exhausted, and in a great deal of pain. X-rays were immediately taken, and he was admitted to the hospital.

Patient was immediately etherized, all stitches released, multiple incisions made through and through, drainage given with four sets of tubes inserted, and Dakin's treatment instituted. The following day patient's temperature was much lower, upper arm swelling had decreased, and evidently at present the situation seemed under control.

The entire dorsal aspect of the forearm, an area of about six inches, was exposed down to the ulna. The wound was doing well and temperature was normal. There was a very large amount of sloughing, and ruptured vessels could be seen. The tourniquet was kept by the bed, because of a possible chance of sloughing and consequent hemorrhage.

The problems presented were: First the saving of the boy's life, which was menaced by the gas infection; second, the saving of the arm, which apparently could be done; third, if the arm was saved, to make a useful member of it by the prevention of deformity and also of too much tying down of muscle and tendon by scar tissue. The dressing was changed every day under as aseptic conditions as possible.

Inasmuch as there was an absence of 3 inches of the radius, it was self-evident that even though the arm were healed there would be a loss of bone substance, and that bone graft could not be put on for some time because of the danger of lighting up the infection. Conservative measures were therefore advised.

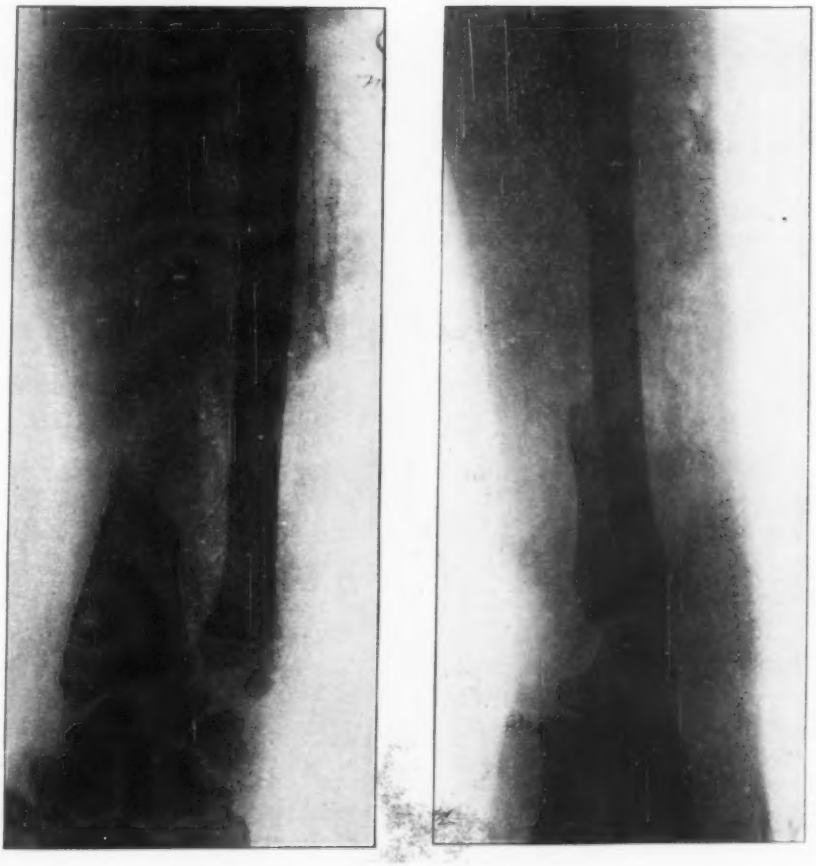


PLATE NO. 1 AND NO. 2

There is a piece of radius missing, extending from a point about three inches above its lower end to a point about four inches higher. There is also evidence of gas bacillus infection in soft tissues, posterior to the injured radius. This area of gas infection includes about one-half inch of forearm and is evidently extending rapidly, as it has involved this much of forearm in twenty-four hours.

(Signed) P. F. Butler.

PLATE NO. 3

X-Ray report shows the old injury of the radius to be now bridged across by a strong bridge of bone. This bridge is somewhat irregular in outline, but apparently composed of solid bone.

Massage and motion were begun long before the wounds were healed, and motions of the wrist and fingers were passively done each day. The patient was a foreigner and a rather difficult individual from whom to secure coöperation. He progressed well, and more and more as the fingers became of use, he was soon encouraged to use the hand and arm actively with the splint on. Granulations came along quickly, and patient was allowed to go about in order to keep him from becoming mentally depressed, and was encouraged to go to the theatre, which had a great value to keeping his general condition good.

April 24, 1921, patient was up and around, and out in the sunshine and doing well. Evidently at this time, as can be seen by the x-ray, there was no residual osteomyelitis of the ends of the radius. On May 6th a small bare piece of bone in the region of the ulna was removed, which had evidently prevented the healing, and Dakin's solution was started again in this region. The posterior aspect of the hand and the infiltration here as well as in the fingers caused considerable thickening of the soft tissue and consequently limitation of motion. Patient was given active exercises and massage. On June 9th he was getting more and more motion in his hand and fingers and was showing steady improvement; the condition was excellent. July 7th patient advised to go back to work as soon as some suitable work could be found.

X-ray taken August 23, 1921, shows the unusual bridging over of solid bone, which united the two ends of the radius. Clinically it was noticed that the patient could rotate the forearm, which he had not been able to do at any previous time.

He reported on March 2, 1922, and the only objection to the whole situation was that because of the slight amount of adduction of the hand at the wrist and the contraction during the period when there was loss of continuity in the radius, he had a deformity. The arm was very satisfactory and no further operative procedures were considered. On the whole the result may be considered excellent, and an unusual one in view of the type of infection and complications.

TREATMENT OF A CASE OF INTRACAPSULAR FRACTURE OF HIP BY WHITMAN METHOD

LOUIS A. O. GODDU, M. D., BOSTON, MASS.

In February, 1922, patient, who was walking across street, slipped on pavement and fell; felt something give in the hip. Was taken home and later sent to the hospital. X-ray taken showed intracapsular fracture of the left femur, with overriding about 1 inch. The writer deemed it advisable to try manipulation and reposition by the Whitman method. Patient was 56 years of age.

Figure No. 1 shows fracture before manipulation.

Figure No. 2, taken through the plaster, shows the hip after manipulation.

OPERATION:

Patient given full anaesthesia. Limb was forcibly adducted and traction made, attempt being made to bring the ends into such an apposition that upward pressure would not disassociate the position by actual measurement from the anterior superior spine to the intrainternal malleolus. Measurements made for length, and as both ends were the same, manipulation was stopped. Plaster cast applied, including the entire left limb, toes, foot, and hip, also the right leg to the knee. Patient was put on a Bradford frame, and turned each day. X-ray taken at the end of seven weeks showed the plaster still holding position, which was excellent. At the end of nine weeks, cast on the right limb was removed, and patient allowed up. After eleven weeks long cast removed and patient put in a short spica extending to the knee.

X-ray (Fig. 3) taken at this time shows excellent position.

Inasmuch as these fractures give such poor results and prove so unsatisfactory, it was considered wise to carry out protective treatment for a longer period. The plaster was therefore bi-valved and removed at night; this kept on for two months.

August 18, 1922. Patient walking without crutches or any support and feeling no pain.

X-ray (Fig. 4) shows the final result at this time.

Relative to the Whitman method in treating intracapsular fractures, this method is ideal if fractures are obtained early and coöperation be had in

FIG. 1

FIG. 2

FIG. 3

FIG. 4

treatment. The writer is likewise frank to say that perhaps many of the poor results may be attributed to the improper manipulations and retentive plaster. Extreme abduction is essential if one is certain that there is reposition of the fracture, and even though we do get absorption of the neck, there is a decrease due to the poor nutrition in this area because of the cutting off of the arteries of supply. We have at least the best means for a stable hip inasmuch as we have a good position. The writer feels that the support is taken away from these cases too quickly, and that it is not always possible to know definitely what sort of union exists and what part nature will take relative to a future process within the fractured area. It seems, therefore, perfectly rational that the hip should be protected with a plaster of Paris cast that can be bi-valved and removed at night so that the patient can carry on motion without weight bearing, and thus obviate any possible harm from too much function. The cast worn during the day allows the weight bearing without motion, and therefore a certain amount of function is permitted in the limb, i.e., weight bearing, which one must concede naturally tends to better nutrition of the part.

One might feel that this case showed an exceptionally good result, but in a perusal of the literature and from the writer's clinical observation it would seem that perhaps we have been prone to accept the treatment of these cases with an idea that the greater portion of the hips in patients past middle life do not unite, but the writer must come forth in stating that there certainly must be a lack of proper control of the case in the majority of these hips that do not apparently do well. The acceptance of the plea that we usually get an ununited fracture must be taken with a grain of salt, as we know, no matter where the fracture, if we do not have a fairly good apposition of the parts there is bound to be a deformity with a non-union or a faulty union, and this same principle should apply to intracapsular fractures of the hip.

It must be admitted that these cases are difficult, and can be properly handled only by adequate manipulation, retention, and careful checking up by x-rays. The fractures should be handled as soon after the accident as possible.

It would seem that the Whitman method certainly overshadows any other method of treatment of these hips in patients past middle age, as they can be turned easily, they are comfortable, and there is no fear of disassociation of the apposition of the fragments once they are in place and held by a proper plaster of Paris cast. One should bear in mind that there is no more disabling condition and disheartening to the patient himself than an ununited fracture of the hip or a hip with some union in a position of deformity, which gives constant pain, because the union is below the point of fracture and upper

portion of the femur, so that the region of the trochanter constantly impinges in the area about the acetabulum and ilium. This soon debilitates and discourages the patient to such an extent that he becomes an easy victim to intercurrent infections and is of no satisfaction to himself or others around him, and in the majority of cases can look forward only to a life of invalidism.

The following letter was received from the patient October 28, 1922.

"I am getting along fine. Going anywhere alone, up and down stairs the regular way, and excepting a lack of speed in some things go about my daily life much as usual. My prize achievement is tying my shoe. It is a bit difficult as yet, and somewhat a contortionist's feat, but I am so thankful to be able to do it at all, for now I am quite independent. I am not walking to suit myself yet, and I am quite sure you would frown if you saw me on the street. Maybe you will decide it is habit."

AN OPERATION FOR THE CORRECTION OF "DROP-FOOT."

BY WILLIS C. CAMPBELL, M. D., MEMPHIS, TENN.

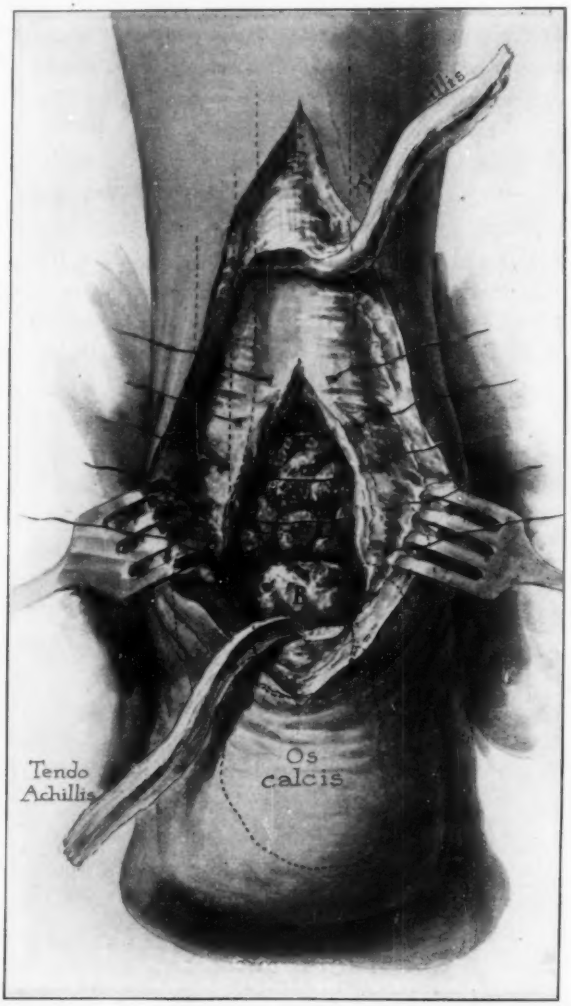
Paralysis of the anterior group of muscles of the leg causes an inability to voluntarily lift the foot or dorsiflex the ankle joint, the so called "drop-foot," which is a common disability and may be the sequela of lead poisoning, destruction of the external popliteal nerve, extensive loss of tendon and muscle, but more frequently the result of anterior poliomyelitis, infantile paralysis.

All operative procedures attempt to suspend the foot from the anterior aspect of the leg with silk ligaments, tendons, and fascia lata, but the results of such methods are uncertain and often disappointing, as the constant force of gravity of the pendulous foot causes elongation of the artifical ligaments and recurrence. Consequently, it is generally admitted that we have no satisfactory method by which permanent correction can be obtained. As stated by the Commission appointed by the American Orthopedic Association for the study of stabilizing operations on the foot, in speaking of drop-foot, "none of the operative methods considered can be confidently recommended as a standard procedure."

In September, 1918, I reported in the Journal of the American Medical Association an operation for the correction of genu recurvatum, which consisted in transferring and attaching the lower third of the posterior surface of the patella, after denuding of cartilage, to the anterior aspect of the tibia, the upper two-thirds extending above the articular surface of the tibia, thus limiting extension of the knee joint. From the principles of this procedure has been evolved a routine operation for the prevention of drop-foot, but attacking the problem from an entirely different angle, the posterior instead of the anterior aspect of the ankle joint. In a large per cent. of paralytic feet it is necessary to remove bone for the purpose of the correction of deformity and stabilization of the mid-tarsal region. These particles of spongy bone may be employed as transplants in order to block plantar flexion. A description of the operation may be better understood if divided into two parts, the technique of the first part is as follows:

An incision is made over the antero-lateral surface, beginning about one inch above the ankle joint, internal to and parallel with the fibula, passing downward to the external cuneiform bone. After division of deep fascia the extensor tendons are reflected inward, where the ligaments and periosteum are severed to bone, thus having easy access to the entire mid-tarsal region.

(This approach we employ as a routine for astragalectomy and practically all radical procedures for deformities of the feet). A small portion of the head of the astragalus is removed and the entire scaphoid bone, or a large portion thereof; the articular cartilage is excised from the posterior surfaces of the cuneiform bones. The calcaneo-cuboid joint is freely excised, and also the calcaneo-astragaloid, thus forming a triple arthrodesis. The scaphoid and particles of bone are placed in a sterile towel or pan and



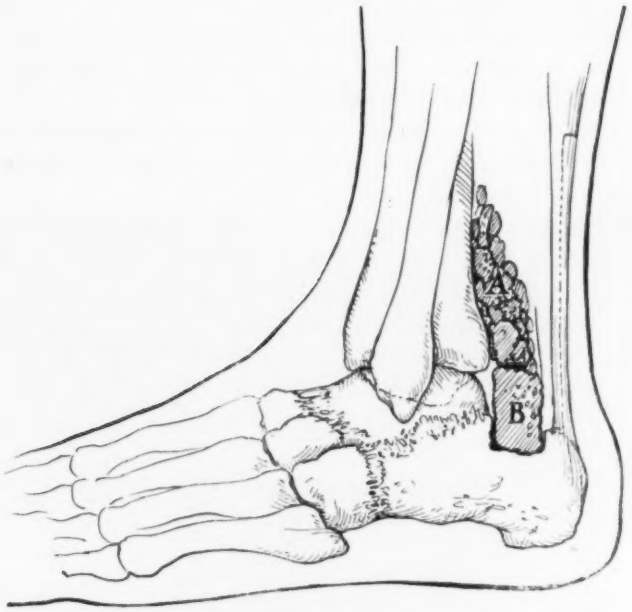
No. 1. Illustrating steps of the operation, showing "B" the scaphoid and "A" small particles of bone making a pyramidal mass.

carefully preserved. The raw bony surfaces are approximated and sutured together with chromic cat-gut, all layers are closed in routine manner. The object so far is to produce a stable foot and does not differ from the principle of Dunn, Davis, Ryerson, and others.

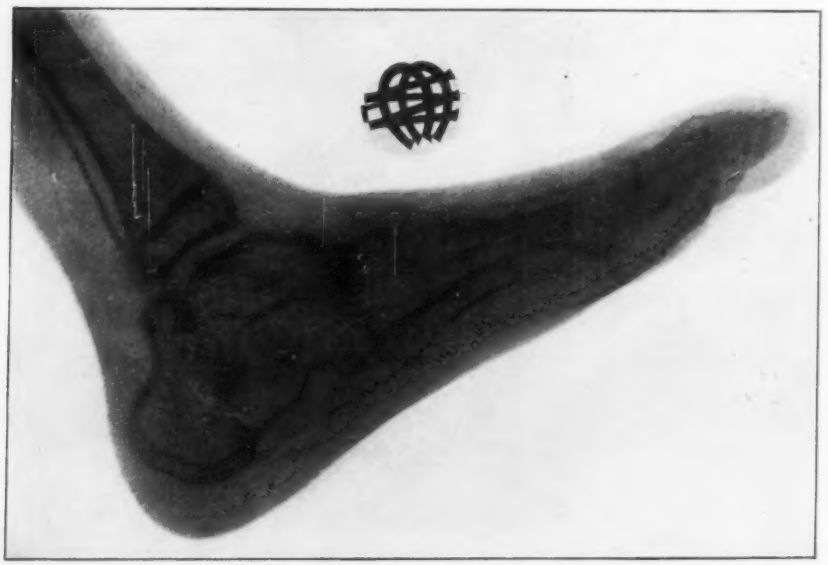
In many, however, a much less radical procedure may be instituted, depending on the indications of the individual case. The technique of the second part is as follows:

Attention by an assistant is next given to the excised bone. The scaphoid and all particles of bone are denuded of cartilage and fibrous tissue, producing one large oval mass and many small particles of spongy bone. A skin incision is now made over the tendo Achillis, and by common Z-plastic method, this structure is severed and reflected above and below. The loose fibrous and areolar tissue is incised in the mid-line and also the posterior

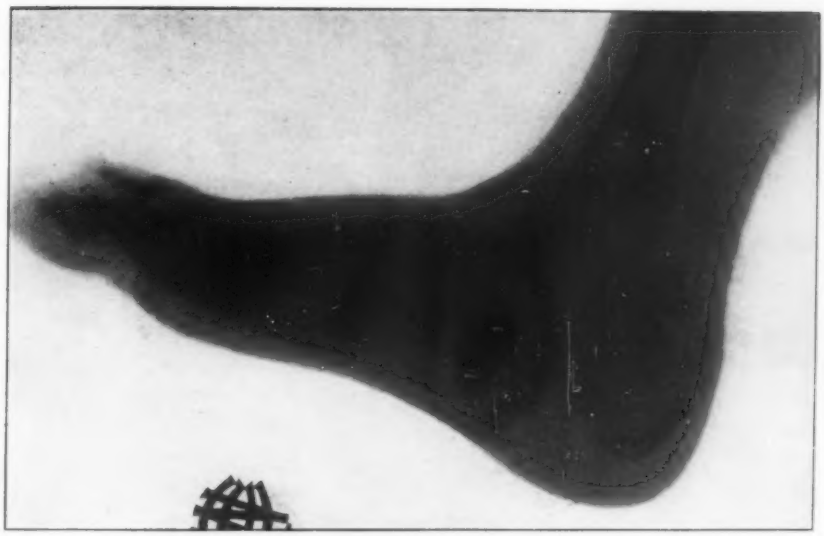
Typical "drop-foot" before operation.



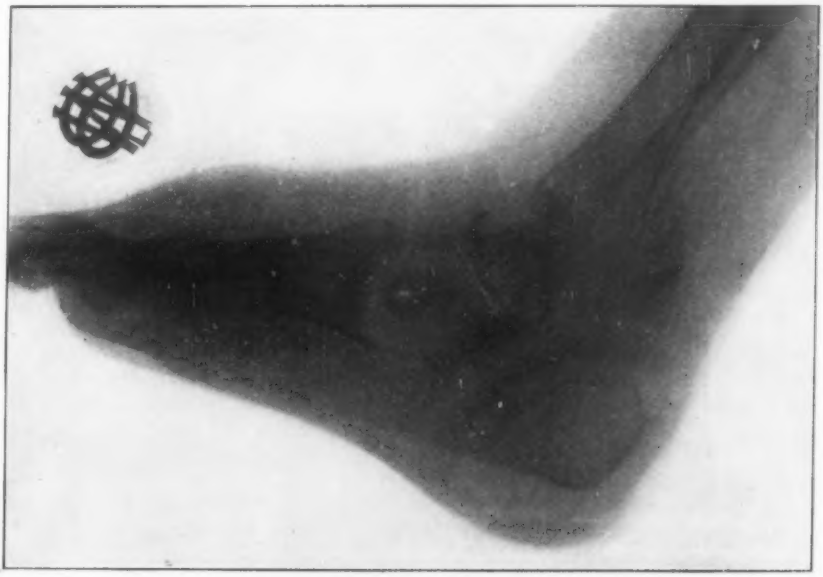
No. 2. (A) Small particles of spongy bone from the tarsal region. (B) Scaphoid bone grafted into os calcis making stop joint.



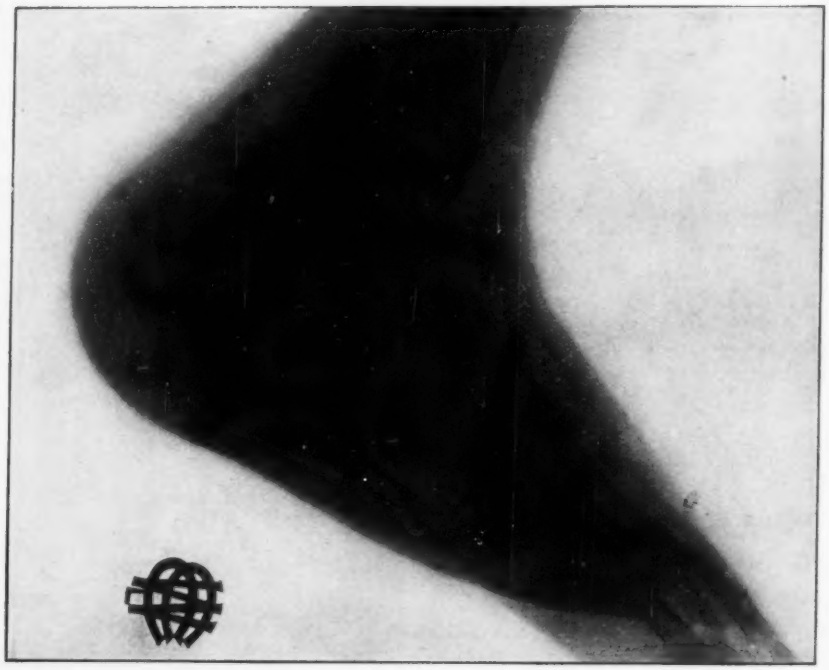
Showing small intra-articular block which has been used in a number of cases and seems to answer the purpose.



Showing anterior and posterior bone block.



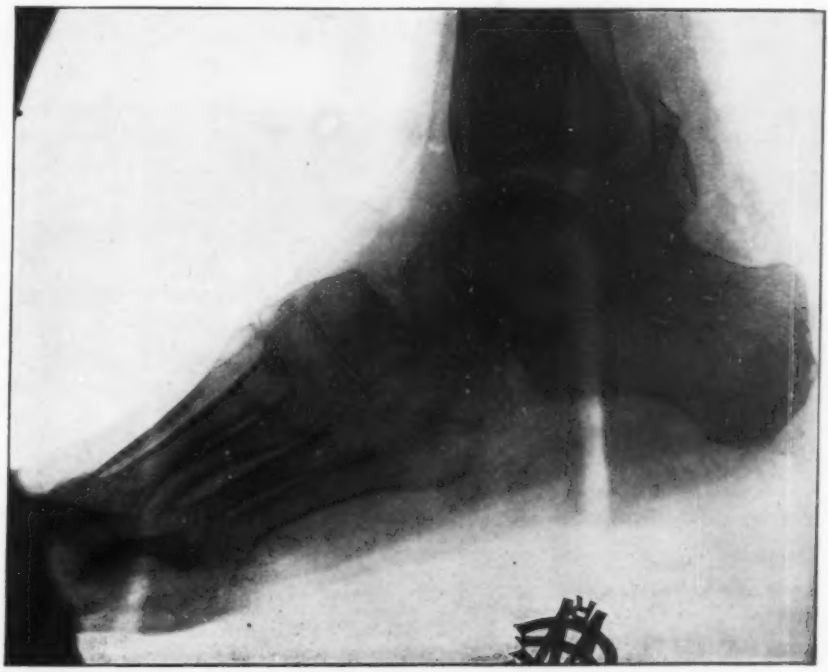
Six months after operation showing organization of fragments into concrete mass.



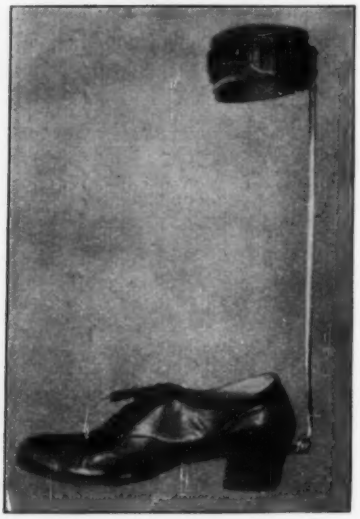
Six weeks after operation showing beginning fusion of fragments.

Three months after bone block operation.

Six months after bone block operation.



One year after operation showing callus completely organized into a new bone process continuous with and a part of the os calcis.



"Drop-foot" brace used in the after treatment.

Six months after tendon sling operation as described in the text.

One year after tendon sling operation as described in the text.

capsule of the ankle joint. With a large periosteal elevator a pyramidal space is cleared, exposing the posterior surface of the tibia, ankle joint, and the superior surface of the os calcis. The foot is dorsiflexed and the posterior extremity of the astragalus is removed. A wedged shaped cavity is made in the os calcis below the posterior extremity of the astragalus, into which the scaphoid is inserted and all the loose particles of spongy bone placed in a pyramidal mass, extending well over the posterior surface of the tibia. The soft parts are sutured snugly to retain the transplants in situ, the tendo Achillis united, fascia and skin closed. The foot is then retained at right angles with a plaster cast. Over correction is especially avoided, as it is preferable to have a slight degree of plantar flexion in order to avoid flat sole or heel walking. At the end of six or eight weeks the cast is removed and X Rays made, which always show definite proliferation. A sequence of radiograms exhibits a gradual organization of bone until there is a solid mass continuous with and forming a part of the os calcis, blocking plantar flexion, as the olecraneon process limits extension in the normal elbow.

In some of the cases associated with genu valgum a wedge of spongy bone has been secured from the lower extremity of the femur by open osteotomy. This presents an excellent subtitute in lieu of or in conjunction with the tarsal transplants when it is desirable to do less radical procedures on the foot.

On removal of the cast, an ankle brace is applied which consists of a single posterior bar and calf band, attached to the shoe by a bar inserted into the heel, having a drop-foot catch at the junction of the heel and single upright bar, which is of decided advantage from a cosmetic standpoint.

The scope of this operation has gradually increased, the procedence having been employed in various lateral deformities of the foot associated with drop-foot, or, whenever for the sake of stability, it was decided to limit plantar flexion. The same principles are also applied to limit dorsal flexion.

Not infrequently drop-foot exists when the anterior group is only partially paralyzed and the dorsiflexors have distinct power, but not sufficient to elevate the foot in walking. In such cases, as an adjunct to the technique described above, the tendons of the peroneus parvus and extensor longus digitorum are severed as low as possible. A tunnel is made transverely through the cuneiform bones, through which the three outer tendons are passed from without inward and the two inner tendons from within outward, thus passing in opposite directions. The foot can be held in any desired position by traction on the ends of the severed tendons, which are stitched together in the midline over the superior surface of the cuneiform bones and to the periosteum. Formerly this method was employed without the bone block and in a limited number was fairly successful, but it did not stand the test of time. Associated however, with the operation for bone block there is no over-stretching, and restoration of function is a material and permanent gain.

The first case was operated on July 1, 1922, since which time the method has been employed in 24 cases. Sufficient time has not elapsed to make a statistical report, but from the evidence offered by the X Ray and clinical findings, in every one of the early cases, there is little doubt that the purpose and mechanical requirements have been definitely accomplished.

DISCUSSION OF DR. CAMPBELL'S PAPER

DR. JAMES WARREN SEVER, Boston, Mass.: I have been asked to open this discussion and I find that it is very easy to accept such an invitation but I have not the slightest idea what I am going to say.

I do not think Dr. Campbell has made it very clear, at least it is not to me, on what particular type of foot he does this very extensive operation. It seems to me that simple drop foot as we usually see it following infantile paralysis, with perhaps a moderate amount of weakness in the anterior tendons, can be easily taken care of by the Gallie method without doing any such extensive or radical operation as Dr. Campbell has described. The fascia transplantations have not been wholly unsuccessful. Fascia does not stretch, and the tendon which is inserted by the Gallie method does not stretch. A shortened tendon should not stretch. To shorten a weakened muscle by any method for holding the foot up will almost invariably give a relapse. To do such an extensive operation for drop foot, which not only shortens the foot to such a degree, but which involves one-half of the foot in a possible future distortion, seems wholly unnecessary. A foot that not only is short but which has a large amount of new bone growth which we cannot limit and in a location where motion occurs, seems to me may eventually be a very useless result. I do not know how long Dr. Campbell has followed the results. My only excuse for appearing at all is for the purpose of starting discussion and getting an idea from the gentlemen here as to whether they think such an extremely radical procedure is necessary. My opinion is that if a patient has a drop foot which requires such an operation, that either the Hoke method or the astragalectomy of Whitman is far superior.

DR. JOHN RIDLON, Chicago, Ill.: I want to say one word in the way of protest that any operation should be performed on such drop feet as those shown in these photographs until it has been demonstrated by long-continued and uninterrupted immobilization that there is not sufficient return in the anterior muscular strength to enable the patient to get along comfortably without any operation at all.

DR. ARMITAGE WHITMAN, New York City: The principle on which this operation was performed was described by a French author in the "Revue d' Orthopédie" several years ago. He accomplished his object by driving a bone peg through the astragalus into the fore part of the foot, leaving the posterior and projecting to act as a block against the posterior border of the lower extremity of the tibia. I also remember pointing out about three years ago to Dr. Cook a case we saw at Hartford in which the same thing had been accomplished by fracture of the astragalus. The patient, a woman, complained of no pain. She could plantar flex the foot to a right angle.

DR. CHARLES A. STONE, St. Louis, Mo.: I would like to say that at the St. Louis Children's Hospital we have a considerable number of these drop feet that have been corrected by the method of Whitman, and they are to us very satisfactory.

DR. ROBERT McE. SCHAUFFLER, Kansas City, Mo.: Dr. Campbell does not need to be defended; he is very well able to do that for himself. It seems to me he has been a little misunderstood in the discussion. He has a proposition to build up a pin on the back of the astragalus, a sort of odontoid process, a bony block. The Xrays show how successfully this has been done. It is not an arthrodesis. It is a finger block of bone sticking up behind like an odontoid process. In intractable cases of drop foot it is an ingenious method of preventing that drop foot, and one which ought to appeal to this Society.

DR. A. H. CILLEY, New York City: I do not see why we should take the scaphoid out of a simple drop foot.

DR. WILLIS C. CAMPBELL, Memphis, Tenn. (closing the discussion): As stated in my report, the Commission of the American Orthopedic Association, appointed to make a survey of various procedures, unanimously agreed, after carefully investigating different methods for the correction of "drop foot" that no known procedure gave satisfactory results. They furthermore stated that radical operative procedures on the skeletal system of the foot were essential to success in unstable paralytic feet, and this was the consensus of opinion of this Association.

Dr. Sever states that the method is too radical and recommends Royal Whitman's astragalectomy or Hoke's operation. Both are as radical as any method I have suggested. Hoke distinctly states that his operation does not attempt to correct "drop foot;" hence is irrelevant to the subject. There is nothing new in triple arthrodesis on the foot, which is frequently necessary for the purpose of fixation and stabilization of flail feet. The amount of bone removed differs as to the condition existing, but as it is usually necessary to remove bone in the tarsal region, one may thus obtain sufficient spongy bone for the purpose of mechanically producing bone bloc posterior to the ankle joint. We have, in some cases, when the foot was quite stable, obtained spongy bone from elsewhere; for instance, when genu valgum was coexistent, excess bone might be obtained from the lower end of the femur, or a wedged shaped piece might be taken from the trochanter or any convenient point where spongy bone may be found.

Dr. Armitage Whitman's description of a French method of grafting bone through the astragalus is in no way parallel to the procedure I have described. Besides, it has been clearly shown that grafts of dense bone, through joints, in children and animals, become absorbed; whereas, I have shown that the mutiple transplants of spongy bone proliferate and become fused to the oscalcis, causing a definite and permanent bloc.

Dr. Ridlon's contention is correct, but the operation is not offered until all measures for restoration of function have failed and a permanent residual paralysis exists.

Dr. Cilley asked why the scaphoid is removed. If ankylosis can be produced between the head of the astragalus and the cuneiform bone, a more stable foot is the result. The question of stabilization of the foot, however, is quite a different problem, my sole purpose being to point out a procedure for the correction of "drop foot." A complete statistical report of end results will be made after sufficient time elapses.

News Notes

The annual meeting of the British Orthopaedic Association will be held at Birmingham on October 19th and 20th.

At the Annual Meeting of the American Orthopaedic Association held in Rochester, New York, on June 7, 8, and 9, 1923, the following officers and committees were appointed:

President: William Stevenson Baer, Baltimore.

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Book Reviews

Reconstructive Surgery of the Upper Extremity. By ARTHUR STEINDLER, M.D., F.A.C.S., Professor of Orthopaedic Surgery, Iowa State University Medical School. D. Appleton and Company. New York and London, 1923.

It has been a pleasure to review this book on reconstructive surgery of the upper extremity by a well known member of the American Orthopedic Association, Professor Arthur Steindler of the Iowa State University Medical School. We know of no book which covers so thoroughly this important subject. It is a subject to which the author has given special attention and to which he brings a fund of very wide experience and mature consideration. From the point of view of wage earning capacity, the function of the upper extremity is probably more important than that of the lower extremity, and any degree of improvement, therefore, which can be brought about by patient training and operative procedures becomes of greatest value. The book is illustrated by clear line drawings of the author's operative procedures and a wealth of personal photographs showing the results following the operative and non-operative methods which he has found to stand the test of time. A thoroughly efficient hospital and a fortunate State law which aid the surgeon very materially in following up his cases, coupled with Professor Steindler's marked ability, have made possible the collection and careful digestion of a vast amount of material which forms the basis of this book. There is much food for thought in its 300 pages, and the surgeon should be able, by their perusal, to reach sound conclusions as to methods of treatment and to give wise advice when he is consulted concerning reconstructive surgery of the upper extremity.

Anaesthetics in Practice and Theory. By J. BLOMFIELD, O.B.E., M.D. Senior Anaesthetist to St. George's Hospital and Lecturer on Anaesthetics to the Medical School. Chicago: Chicago Medical Book Company, 1923.

This is presented as a textbook for practitioners and students. As an introduction it describes in a comprehensive, necessarily brief manner, the development of anaesthesia from ancient and medieval to modern times, from the stages of narcosis and hypno-narcosis to inhalation and local administration. It touches briefly upon the various theories of the nature of anaesthesia, drawing upon the phenomena observed in vegetable and animal experimentation. The physical and chemical properties of the various general anaesthetics are considered in detail; likewise the methods of preparation and preservation, and the impurities which are to be guarded against. The physiological action of chloroform, ether, nitrous oxide, and ethyl chloride is carefully analyzed, with a brief discussion of the less frequently used agents.

About one third of the text is devoted to the induction of general anaethesia. Emphasis is laid mainly upon the administration of ether, nitrous oxide, chloroform, and ethyl chloride; to a lesser degree, of the minor agents and various mixtures. The author duly emphasizes the careful preparation of the patient and the proper environment. He describes in detail the technique of the various methods of administration and the apparatus which he believes most useful. The signs indicative of

a normal progress are minutely explained; likewise those indicating the intervention of undesirable conditions. The method of making a proper choice of an anaesthetic, as affected by the position and nature of the operation and the physical and mental condition of the patient, is fully discussed. Attention is given to preliminary drug therapy, to the cause and treatment of the accidents or other undesirable conditions that may complicate or follow anaesthesia. The unusual uses of anaesthesia are briefly noted.

A rather cursory attention is given to the technique of local, spinal, and sacral analgesia, the indications for, and scope of, their use, the various drugs available and the undesirable effects. Finally, the fatalities of anaesthesia are considered: their cause, frequency, and certain of their medico-legal aspects. A complete index of the text is appended.

This work constitutes a valuable contribution to the literature of anaesthesia. Its chief value lies in the mass of practical knowledge which the author has incorporated, the result of his own experience and keen observation. While it deals in an eminently readable manner with the theory, practice, and art of anaesthesia, it is not, and apparently is not intended to be, an exhaustive treatise. The main attention is focused upon general anaesthesia. Comparatively little space is devoted to local, regional, and spinal analgesia. Though sparingly illustrated, it gives an adequate picture of the apparatus which, in the author's opinion, is most useful. As a concise, easily accessible guide to general anaesthesia it will be found of very considerable value.

Foot Knowledge. By HERMAN W. MARSHALL, M.D. Boston: Boot and Shoe Recorder Publishing Company.

This contribution to topics of feet and shoes includes chapters that will be of interest to every orthopaedic surgeon.

There is a compilation of current notions about feet, based upon an unusually exhaustive questionnaire of fifty items. The set of questions was voted on and commented on by one hundred orthopaedic surgeons and thirty-five shoe dealers scattered throughout the United States.

Side by side, presenting different viewpoints, are opinions from conservative scientific men and progressive shoe men. Despite numerous interesting variations in opinion, there was, in the vote that was taken on the fifty statements submitted, 88% of agreement with the prepared list among orthopaedic surgeons and 82% of agreement among shoe dealers.

The writer states that the unique combined nature of tabulated results prevented their presentation to the medical profession through usual channels of strictly scientific journals.

The book presents interesting evidence, as to how far a progressive trade journal will go in attempting to enlighten its readers. There are nineteen very short chapters written in non-technical language, with numerous illustrations, describing fundamental medical ideas about shoes and feet. There are four chapters dealing with the author's personal experience in wearing various types of shoes.

Many readers will not agree with all of the author's statements and interpretations, but the text is fairly accurate and pictures are carefully selected. There are a number of minor mistakes which would not appear in a carefully prepared and strictly scientific publication; but these may well be forgiven when the fact is considered that the book is a pioneer trade publication.

Current Orthopaedic Literature

PARALYTIC CONDITIONS

AFTER CARE OF INFANTILE PARALYSIS CASES OF THE 1916 EPIDEMIC IN BROOKLYN. H. G. Dunham and Thomas J. Riley. *Journal A. M. A.*, January 27, 1923.

Attention is called to the large incidence of non-paralytic or abortive forms of infantile paralysis, especially to their importance as possible distributors of the disease. It is stated that this form is very common and probably afflicts a large proportion of the population in early life. The disease is said to be increasing and to be endemic in some parts of Europe. The abortive form is prone to go unrecognized. Seasonal relation is marked, a large percentage occurring in summer. Transmission by secretions of nose and throat has been demonstrated. The erratic susceptibility among those exposed may be due to natural immunity.

A significant finding in the epidemic report was that a large percentage of those affected had diseased noses and throats, while per contra, only a small group of patients previously operated upon for tonsils and adenoids contracted the disease, and in these the percentage of recoveries was much higher than in those who had not been operated upon. One attack confers immunity. The mortality in the epidemic was approximately twenty-five per cent. A majority of patients were under five years of age. The proper isolation period is two weeks.

The characteristics of the cerebro-spinal fluid during the attack are described. The fact is noted that poliomyelitis attacks both motor and sensory portions of the cord, but the motor side bears the brunt of the damage.

The severity of the onset bears no relation to the extent of the subsequent paralysis. There are no characteristic signs or symptoms, save the paralyses. Pain along spine, legs, and neck, fever and headache, a drowsy mental state, becoming irritable during manipulation, are frequent.

The character of the spinal fluid is suggested as the most valuable aid in clearing up the diagnosis before paralysis occurs. The isolation for a few days of all suspicious cases, particularly during an epidemic, is urgently necessary for prophylaxis.

As to the prognosis, it is stated that the younger the child, the nearer does restoration of function approximate the normal status.

All the cases reported were given massage and muscle training, which was most effective when given by trained operators. The lapse of a considerable length of time between the development of the disease and the beginning of treatment is no bar to improvement, even though deformities have occurred.

The most frequent combination of involvement in the series was back and lower abdomen with both lower extremities. The involvements of upper extremity did not

respond to treatment as readily as those of lower extremity. Exercise of muscles, pushed to the point of fatigue, is more harmful than no treatment.

The end results of the operative procedures carried out in this series are not commented upon, the time elapsed being considered too short.—*C. L. Lowman, M. D., Los Angeles, Calif.*

PARALYSIS OF THE SCAPULAR GIRDLE. E. Smeesters. *Arch. Franco-Belges de Chir.*, July, 1922, p. 951.

The case reported is that of a girl of 15, who had infantile paralysis at 2 years of age. The ultimate condition was a complete paralysis of all of the muscles of the right shoulder with the exception of the pectoralis major, infraspinatus, and trapezius, which were weak. The hand and forearm were good. The only movement of the right arm was adduction. The humerus was usually luxated anteriorly. At the operation the pectoralis was lengthened, the arm abducted, the anterior capsule reefed, and an attempt made to use the trapezius and infraspinatus as abductors. Six weeks later the patient was able to get some abduction and the result seemed to be good. However, eight days later subluxation occurred and could not be reduced, even under full anesthesia. Then arthrodesis was done. This was successful.—*J. Albert Key, M.D., Baltimore, Md.*

FRACTURES AND DISLOCATIONS.

A CASE OF POSTERIOR DISPLACEMENT OF THE SEVENTH CERVICAL VERTEBRA WITH ISOLATED ROOT COMPRESSION. J. Cahen. *Archiv. Franco-Belges de Chir.*, 1922, 25, No. 10, p. 945.

The case is that of a man of 53 who was injured in an automobile accident. Upon regaining consciousness six hours after the accident he was much agitated, very noisy, and complained of severe pain in the neck and arms. Two or three days later the arms were completely paralysed. Fifteen days later there was considerable atrophy of the right hand and marked formication and hyperesthesia. An X-ray showed a posterior displacement of the seventh cervical vertebra. Six months later there was some persistent paralysis and formication, more marked on the right. The diagnosis was not made until some months after the accident and then manual reduction was attempted, but was not successful. Open operation was refused. The patient became an invalid.—*J. Albert Key, M.D., Baltimore, Md.*

CONTRIBUTION TO THE STUDY OF THE DISLOCATION OF THE HEAD OF THE RADIUS WITHOUT FRACTURE OF THE ULNA. A. Contargyris. *La Grèce Médicale*, March-April, 1922, p. 9.

In this article the author gives a general outline of the lesion, considering history, pathology, symptoms, diagnosis, and therapy. He reports two cases which he presented before the Medico-Surgical Society of Athens.

Case 1. A soldier, 28 years of age, with a forward dislocation of the head of the left radius, without fracture of the left ulna, caused by one of his comrades falling on the posterior surface of his outstretched left arm. Although reposition of the head of the radius was not secured, the soldier, six months later, presented no functional disability.

Case 2. Soldier, 22 years of age, with outward dislocation of the head of the left radius, caused by a fall upon the left elbow, with the forearm in flexion and forced pronation. Ulna not fractured. Reposition was not secured, but one year after the accident there was no complaint of serious functional difficulty.

The author concludes that this dislocation is not as rare as was formerly supposed and that the prognosis is good.

In regard to treatment, the author favors the use of hot baths and massage, reserving open operation solely for the cases where failure to replace the head of the radius causes serious functional disability.

LATERAL SUBLUXATION OF THE THIRD CERVICAL VERTEBRA ON THE FOURTH. Gruget. *Arch. Franco-Belges de Chir.*, July, 1922, 25, No. 10, p. 939.

The case reported is that of a young man of 20, who fell a distance of about 5 metres, striking his head. He fainted. When he became conscious he had no great pain, but bystanders said that his head was crosswise. The next day there was severe torticollis and all the movements of the head and left shoulder and arm were limited and painful. Eight days later he came to the clinic with head inclined to left and rotated to right and the left shoulder raised. There was marked tenderness at the level of the upper four cervical vertebrae. An X-ray showed the third cervical vertebra displaced laterally upon the fourth. The patient was placed in bed with head traction of 5 kilos. On the fourth day the deviation was less pronounced, and without anesthesia reduction was accomplished by extension, flexion, and rotation. There was no perceptible snap. Three months later there was no trace of the accident.—*J. Albert Key, M.D., Baltimore, Md.*

THE OPTIMUM TIME FOR OSTEOSYNTHESIS IN FRACTURES. A. Lambotte. *Archiv. Franco-Belges de Chir.*, 26, 57, Jan., 1923.

The author states that for some years past he has maintained that osteosynthesis, if performed at the proper time, hastens rather than retards consolidation in fractures. In simple fractures of the femur or ankle in adults he recommends waiting until 12 to 15 days after the injury before operating. In fractures of the arm, forearm, or leg, the period is 8 to 10 days. A patella does best if sutured at about the tenth day after the injury. In children the time is shortened to 4 to 6 days. On the other hand, if osteosynthesis is performed immediately after the injury the introduction of foreign material has a tendency to cause a delay in union. This theory has been confirmed by a number of recent cases on which, for reasons independent of his will, he operated immediately after the injury. In all of them union was delayed.—*J. Albert Key, M.D., Baltimore.*

THE VALUE OF GRANT'S PINS IN THE OPEN TREATMENT OF FRACTURES AS SEEN ROENTGENOLOGICALLY. D. Y. Keith and J. Paul Keith, M.D. *Am. Jour. of Roentgenology*, March, 1923.

The writers describe the mechanism and construction of Grant's pins, give the history of their creation and use by Dr. H. H. Grant up to 1915, the weaknesses of the pins as used by Grant, and describe the improvements which they have made, the improvements giving greater strength and convenience.

Surgical points emphasized are: screws should pass through the medullary canal to opposite cortex; screws must be of good metal to insure greater strength. Drill holes should be same size as gimlets. Reduction is better in experienced hands, excellent in the skilled surgeon's hands. Especially excellent for aid in reduction and maintenance of position in the robust, where violent muscular action is such a potent factor in the production of malposition; also at points where displacement is so prone to occur. These pins lessen trauma in the process of reduction. The pins are easily removed, requiring no anesthetic. They are easily applied, can be used easily in compound fractures. Thirteen cuts are given illustrative of the pins and various forms of fractures and their treatment.—*William Jackson Merrill, M.D., Philadelphia, Pa.*

A New Method or Treatment of Irreducible, Acquired or Congenital Hip Dislocations. By Adolf Lorenz, M.D. *New York Med. Journ. and Med. Rec.*, Feb. 7, 1923.

The following conditions, luxations, pseudarthrosis colli femoris, coxa vara luxans, have something in common anatomically, and there arises a nearly equal disturbance of function. This disturbance in function is due to a loosened connection of the upper end of the femur with the pelvis. The pelvis has lost the direct bony support of the femur; is merely suspended at its upper parts by soft and yielding tissues, the pelvitrochanteric muscles, and the capsule. These soft parts, subject to undue strain, especially in adults of heavier weight, become painful.

The limping of such patients is due not only to deficient bony support of the pelvis, but also to the fact that the power of the pelvitrochanteric muscles is deficient, for by the shortened distance of their points of insertion they have become too long, have lost their normal leverage, and besides are weakened from disuse. The contralateral side of the pelvis drops until the lateral aspect of the tuber ischii reaches contact with the inner aspect of the upper femur. The lateral dropping of the pelvis at each step accounts for the adduction contraction. The point is stressed that flexion and adduction are very commonly seen in this group of cases.

The purpose of the so-called bifurcation operation is to provide a bony support in place of the yielding soft tissue support. This is accomplished by oblique osteotomy at the level of the acetabulum. The upper end of the lower fragment is thrust against the capsule and held in this position by abduction, while the lower end of the upper fragment is adducted and made to lie in contact with the lower fragment. In this way the upper end of the lower fragment becomes an artificial head, giving stability, while the adducted position of the upper fragment gives better action to the pelvitrochanteric muscles. The operation entails some shortening which, however, can be equalized by the tilting of the pelvis at the site of the operation. Stress must be laid on the fact that not the shortening, but the elastic suspension of the body upon the upper end of the femur is the source of the troubles of the patient. The operation also causes some impairment of motion, chiefly flexion.

The results in properly selected cases have been good, particularly as to function, but the cosmetic results have also been very satisfactory.

Some sixty patients have been operated upon by this method.

DESCRIPTION OF THE OPERATION.

The patient is placed upon the sound side, the diseased thigh being slightly flexed so as to cover the site of the acetabulum. A longitudinal incision of about ten centimeters is made through the skin and muscles until the outer surface of the femur is laid bare. Oblique osteotomy is then done, a long and oblique line extending from the anterior aspect posteriorly and distally. The upper extremity of the cut should correspond with the upper level of the acetabulum. The limb is abducted until the upper end of the lower fragment comes to rest in the empty acetabulum, that is, on the anterior capsular wall. The lower end of the fragment is pushed inwards and made to lie in contact with the outer surface of the upper end of the lower fragment.

The limb is fixed in thirty-five degrees of abduction in a plaster of Paris spica from the waist to the toes, taking care to maintain adduction of the upper fragment by tightening the rollers over the operative field. The patient is allowed up on crutches in about two weeks, in six weeks the bandage is cut and the knee joint moved, and in three months all support is removed.

The after treatment consists of massage and gymnastics of the pelvitrochanteric muscles.

In conclusion the author states that his bifurication operation is applicable:

1. In cases of irreducible congenital hip dislocation.
2. Eventually in cases of refractory congenital luxations.
3. In irreducible traumatic hip luxations.
4. In pathological dislocations due to osteomyelitis or tuberculosis.
5. In the severest cases of coxa vara (Coxa vara luxans).
6. In cases of pseudarthrosis colli femoris.
7. In cured cases of tuberculosis of the hip complicated with frequent attacks of severe pain.
8. Eventually in cases of severe arthritis deformans coxae in older patients, to control pain by relieving pressure in the joint.

The article is a long one with a number of drawings and could be read with interest by those who deal with this group of cases.

—LeRoy C. Abbott, M.D., Ann Arbor, Mich.

OPEN INTERVENTION IN MALLEOLAR FRACTURES. G. Picot. *Jour. de Chir*, 21, 529, 1923.

The irreducibility of certain malleolar fractures and the poor results in those not completely reduced led the author to operate on twelve recent cases. All showed fractures of the posterior margin of the tibia which were not always visible in the X-ray plate.

An operation suitable for the majority of cases is described. The approach is by a J incision along the lateral border of the tendo Achillis and swung inwards distally. The tendo Achillis is divided obliquely and turned back, the communicating artery is cut between ligatures, and the flexor longus hallucis is cut from the fibula in the lower portion of its attachment and retracted mesially to expose the seat of the fracture. The periosteum of the tibia is incised and the fracture is reduced by hooking up the proximal fragment, while an assistant flexes

the foot and presses down upon the distal fragment. Coaptation must be perfect. Fixation is maintained by a screw. The wound is closed in layers and the tendo Achillis is lengthened. Movement is begun on the fourth or fifth day and walking in thirty days. Good results were obtained in all 12 cases.—*J. Albert Key, M.D., Baltimore.*

THE RATIONAL TREATMENT OF FRACTURES OF THE UPPER END OF THE HUMERUS: REPORT OF END-RESULTS. James Warren Sever. *Journal A. M. A.*, June 2, 1923, p. 1603.

Author emphasizes the absolute necessity of the abduction treatment of fractures of upper end of the humerus and notes the generally poor results obtained in these fractures as a result of the usual method of treatment with reference to subsequent function. He declares that better results will be obtained in less time if traction following the reduction of the fragments is used in the abducted and outwardly rotated and elevated position rather than by using the older and usual method which employs the shoulder cap, sling, and Velpeau bandage.

Classification of Fractures of Upper End of Humerus

Class 1. Simple fracture of greater tuberosity without displacement: A. With upward and outward rotation of fragment, may be associated with dislocation of shoulder.

Class 2. Simple fracture of surgical or anatomic neck without displacement, or with impaction of fragment: A. With displacement of fragment, but without dislocation of head: B. With displacement of fragments and complete dislocation of head, generally subcoracoid.

Class 3. Fracture of neck of humerus, generally comminuted, with fracture of shaft, without dislocation of head.

Conclusions

These points are essential in the treatment of fractures of the upper end of the humerus:

1. Anatomic restoration of fragments is best obtained by abduction, outward rotation, and elevation of the humerus.
2. Traction in this position is essential for from four or five days to two or three weeks.
3. A satisfactory ambulatory splint may be employed rather than bed treatment.
4. Better and more quickly obtained functional results may be secured by this method than by any other.
5. Operation, except in certain cases of fracture dislocations, is generally unnecessary to restore fractured surfaces.—*E. Z. Holt, M.D., Atlantic City, N. J.*

A CASE OF FRACTURE-LUXATION OF THE CERVICAL SPINE. E. Vandeput. *Arch. Franco-Belges de Chir.*, 1922, 25, No. 10, p. 942.

The case reported is that of a young man who, while swimming, dove and struck another swimmer. Immediate quadriplegia resulted. There was dissociated root paralysis of the upper extremities with complete motor and sensory paralysis below

the sixth cervical. There was abolition of the deep reflexes and loss of sphincter control. An X-ray showed a fracture and backward displacement of the fifth cervical vertebra. A diagnosis of total anatomic section of the cord was made and operative interference was not deemed justifiable. Bed-sores developed rapidly and the patient died. Autopsy proved the diagnosis to have been correct. The author states that the diagnosis of complete anatomic and functional section is not always as clear as in this case and that when there is any doubt of the condition a laminectomy should be performed on the second or third day in order to relieve pressure and limit degeneration.—*J. Albert Key, M.D., Baltimore, Md.*

RETROSTERNAL LUXATION OF THE CLAVICLE. CONSERVATIVE OR OPERATIVE TREATMENT? Kurt Wachendorf. *Zentralbl. f. Chir.*, March 31, 1923, p. 514.

From the review of the limited number of reported cases, the author concludes that surgeons have disregarded the conservative treatment in favor of the operative. He quotes a case which, notwithstanding its unfavorable complications, has yielded an excellent permanent result without operative procedures. Briefly the history is as follows:

Man of 49 was thrown off a wagon and struck the left side of his chest. Examination revealed a marked swelling and blue-red discoloration extending from the sternum to past the left mammary line and from the fifth rib to above the left clavicle. Intense pain with each breath. Distinct crepitation over second to fifth ribs. In the region of the left sterno-clavicular joint was a depression and the edge of the sternum was decidedly palpable; the sternal end of the clavicle, not palpable, was lost behind the sternum. Abduction of the arm painful, and possible to the horizontal position only. X-ray showed a typical sterno-clavicular dislocation and multiple rib fractures near the sternum.

Treatment.—Adhesive strapping for the rib fractures. Forcible backward pressure of both shoulders resulted in a comparatively easy replacement of the dislocated clavicle. Patient was placed on the back with a sandbag between the shoulders and another sandbag on the left shoulder to guard against reluxation. The next day slight motion subluxated the clavicle again. Second replacement with the same ease, and retention of both arms in extreme backward position by means of circular bandages. Patient placed on his back as before. Twenty-six days later uneventful recovery and discharge of patient from the hospital. Arm motion was free and painless. The fractured ribs, though healed, were not in perfect apposition, viz., the outer fracture ends were displaced mesially to the sternal fracture ends. In consequence of this the diameters of the chest varied on the two sides. the left being somewhat flatter than the right. Notwithstanding this untoward complication which would hinder replacement and favor reluxation, the result was an excellent one with conservative treatment. This speaks, at least, for a trial of the nonoperative method.—*A. Gottlieb, M.D., Los Angeles, Calif.*

POSTURAL DEFECTS.

RESULTS OF EXERCISE FOR THE CORRECTION OF POSTURAL DEFECTS. By Robert Jay Cook, M.D. *New York Med. Journ. and Med. Rec.*, Feb. 7, 1923.

The common postural defects found among men entering Yale are round shoulders, increased antero-posterior curvature, as kyphosis or round back, lordosis or

hollow back, scoliosis, either postural or structural, flat chest, prominent abdomen, and weak feet, which term includes the several types of foot strain and foot abnormalities.

The author calls attention to the fact that in two examinations of Freshmen of Yale,—in the first instance, 1,393 men, and in the second instance 2,200,—but 25 per cent. of these men had a normal spinal curvature, that over 50 per cent. had an antero-posterior curvature. The chest was flat in 56 per cent. of cases and the abdomen was prominent beyond the normal in 42 per cent. of the men.

These defects are found in men who have just completed the preparatory school.

The author makes a plea for corrective therapy during early life so that the poor postures found so commonly among adults may be avoided.

It is interesting to note the postures of men entering from various preparatory schools. In general those from military schools lead, boys from private preparatory schools come next, and following this the high school group. Following the war there was exception to this and those who had been under military training in high schools outrated many who had been in private preparatory schools.

The general plan of treatment has been to give the correctional work from Thanksgiving to Easter, a period of fifteen weeks. The contracted muscles are stretched, effort is made to obtain greater flexibility of the thorax and freedom of the shoulder girdle, then increase in tone of the trunk muscles.

In the past two years five hundred men have been examined and grouped according to postural defects.

The man who had scoliosis combined with increase in the antero-posterior curvature improved both conditions, even though his exercises were directed mainly at overcoming the major one.

A number of tables are given showing the following results: In increased antero-posterior curvature of the spine, 66 cases of kypholordosis, 53 cases of kyphosis were corrected, 116 cases of kypholordosis were partially corrected, and 8 cases of kyphosis were partially corrected. There were 80 cases of kypholordosis and 40 cases of kyphosis in which no correction was made and 9 cases in which the defect became worse. Correction of round back is the most difficult part of the problem in the correction of the postural defects in this group of men.

Table II deals with carrying of the head and neck too far forward. Correction of this deformity has been quite satisfactory. In many cases it is associated with round back. The author urged correction of this deformity as well as the correction of carrying the neck and head too far forward. In this group 212 cases were completely corrected, 145 partially corrected, while 73 cases showed no improvement and 8 cases showed an increase in the carrying angle of the neck.

The result in the correction of round shoulders shows that 168 were completely corrected, 189 partially corrected and 90 cases showed no improvement, while 7 showed an increase in defect.

Our failure in part seems traceable to the attitude of the student and part may be due to pushing too rapidly the man who has outgrown his physical strength.

Reviewing our cases of postural scoliosis we find 101 cases completely corrected, 94 partially corrected, 62 show no improvement, and 21 show an increase in curvature.

These defects of posture found among young men do not tend to disappear without corrective work, but they can be overcome by this training, some by the nature

and severity of the defect requiring a longer period than others. Since they are formed long before the student enters college a great deal could be accomplished by preventive measures instituted in the grade and high schools. The question is often raised as to whether the correction is permanent or temporary. We have examined in the past fall those who were given correctional work in the preceding year and in these cases we can say that the improvement has remained.—*Le Roy C. Abbott, M.D., Ann Arbor, Mich.*

FAULTY POSTURE AS A CAUSE OF OBSCURE DIGESTIVE AND NUTRITIONAL DISORDERS; REPORT OF TREATMENT IN FIFTY CASES. Percival Nicholson, M.D. *Pennsylvania Med. Journ.*, Feb., 1923.

This brief article presents certain factors as causes of faulty postures and some of the consequent sequelae. The author states that in the study of adults ("recruits of the world war") nearly 50 per cent were incapacitated by faulty posture, that it is essential to have a "clear understanding" of normal posture, but does not emphasize the fact that each case is a problem *per se*, that no pattern of rules governing habits of good posture can be made to correctly apply to all cases. He does not bring out the fact that the position of the shoulder girdle depends upon the contour of the chest and that the position of the scapulae is chiefly controlled by the shape of the chest.

He outlines some rules of good posture for the trunk but does not give sufficient stress to the importance of maintaining a high position of the sternum and anterior chest. If the sternum be held high, the cervical, dorsal, and lumbar spine and the pelvis will fall into the normal position for that individual, if the feet are parallel and the knees straight.

Nicholson points out some of the skeletal and visceral changes that result from faulty posture; alludes to congenital (meaning apparently conditions affecting the primary development in the embryonal period) factors that predispose to faulty posture; briefly discusses "acquired poor posture," but does not emphasize here the fact that bad posture is usually a sequela, not a first cause. He discusses briefly the serious effects of skeletal deformities, and gives a special place to cases resulting from unbalanced diet (we recall the fact that thousands of children have "unbalanced diet" and yet good posture). He points out very pertinently the dangers of giving muscles their function too soon after depleting illness. He states the "symptoms" vary as to the character and extent of the postural defect and its duration, but does not add to these conditions the influence of the personal equation. He enumerates defects and states that they are due to "incorrect bodily mechanics," and here leaves out many associated vital conditions. Eight cuts illustrate variations in posture. Eleven cases are reported. The efficiency of a proper abdominal belt is emphasized under "treatment."—*William Jackson Merrill, M.D., Philadelphia, Pa.*

BONE SURGERY.

THE LORENZ BIFURCATION OPERATION. A PRELIMINARY REPORT. By Dexter D. Ashley, M.D. *New York Med. Journ. and Med. Rec.*, Feb. 7, 1923.

The author states that time and again patients have come to him with long standing deformities of the iliofemoral articulation—unstable, painful—due to dis-

ease, fracture, or congenital malformation. For these patients he has been unable to suggest any satisfactory method of relief.

The bifurcation operation of Lorenz has been of great benefit in obtaining relief and it is a simple operation without any risk. The details of the technique are given, but are quite similar to those stated in the previous article.

The broad application of this operation can hardly be appreciated at first glance. Foremost of the conditions to be benefited is the old, ununited fracture of the neck of the femur. If this operation were applicable to this condition alone, it would be a remarkable addition to our surgical procedure. In the second place this operation is indicated in pathological, unstable conditions due to tuberculosis, acute infections, acute arthritis neonatorum. Third, it is available also in cases of old, painful congenital dislocations, or pathological dislocations after typhoid fever, osteomyelitis, and other similar conditions.—*Le Roy C. Abbott, Ann Arbor, Mich.*

THE SURGICAL CORRECTION OF DEFORMITIES OF THE EXTREMITIES. M. Cadenat. *Journal de Chirurgie,* March, 1923, p. 273.

The author discusses the difficulties encountered in cutting an oblique wedge for the correction of a deformity in two planes. To overcome this he has devised a guiding compass adjustable in two planes. Tracings are made from roentgenograms taken at right angles to one another, and the angles of the required wedge are determined in the usual way by cutting and straightening the tracings. The compass is set at the required angles and boiled with the instruments. In operating, the bone is cut at approximately right angles and the compass then used to guide the saw in cutting the oblique wedge from one bone end. The method permits of an exact correction of the deformity. However, it has been the experience of the reviewer that the chief difficulty in these operations is not so much the bone carpentry as it is the difficulty in holding the bones in the correct position while the plaster bandage is being applied.—*J. Albert Key, M.D., Baltimore.*

TRANSFERENCE OF THE CREST OF THE ILIUM FOR FLEXION CONTRACTURE OF THE HIP. Willis C. Campbell. *Southern Med. Jour.,* April, 1923, p. 289.

This operation is intended for severe flexion contracture at the hip. It is more extensive than the Soutter operation, although founded upon the same general principle. It is also said to overcome any associated abduction deformity at the hip. The operation is as follows: "The skin is incised along the anterior half or two-thirds of the crest of the ilium to the anterior superior spine and then downward to the outer aspect of the rectus muscle for about two to four inches, a typical Sprengel approach to the hip, recently advocated by Smith-Peterson. The superficial and deep fascia are incised to the crest and anterior superior spine. With sharp osteotome the anterior superior spine is removed. The outer one-fourth of the crest is chiseled through, from before backward, or the anterior two-thirds or the entire crest, as the occasion demands, after which a heavy osteotome peels the entire mass subperiosteally downwards to the rim of the acetabulum, above which

a tract of bone is denuded about one inch in diameter and parallel with the crest of the ilium. The raw surfaces of the transferred crest of the ilium and anterior superior spine fall, by gravity, so that raw bony surfaces approximate. If this does not reduce the flexion, the anterior structures, such as the psoas, fascia, or capsule of the hip joint, may be easily attacked. The superficial fascia above is stitched to the deep fascia at a point below, bringing the skin incision about one inch below the crest of the ilium, avoiding possible pressure. The skin is closed with dermal sutures. Plaster cast is applied in hyperextension, which remains eight weeks." He has had no fatalities or alarming symptoms. This seems to be an advance over the excellent Soutter operation and should be a great aid in the severer cases. The operation is illustrated and some photographs shown.—*F. G. Hodgson, M.D., Atlanta, Ga.*

Researches on Grafts of Bone Fixed in Alcohol and on the Mechanism of Osteogenesis. L. Christophe. *Archives Franco-Belges de Chirurgie*, 26, 13, Jan., 1923.

The work was undertaken in an effort to explain a remarkable case operated upon by Professor Delrez in which an intact patella with the patellar ligament and part of the quadriceps tendon was removed from a man at autopsy, fixed in 80 per cent. alcohol for three days, and then transplanted to the knee of a man who had had his patella removed in débriding a shell wound. The dead patella was not only tolerated, but normal function was restored to the knee, and in the roentgenogram taken four years later the patella appeared to be perfectly normal.

This was a brilliant application to bone of the researches of Nageotte and Sencert on the transplantation of dead grafts of tendons and nerves.

Christophe used rabbits, foxes, and dogs. Most of his experiments consisted of the transplanting of alcohol fixed ribs of rabbits. Some of the grafts were first boiled and then fixed in alcohol. From studies on the grafts removed at various periods up to four months after the operation he concludes that dead grafts of the rabbit bone transplanted into another rabbit of the same sex in a position of physiological function frequently are not absorbed but are repopulated by living cells which migrate in from the host.

After thirty-four days the graft cannot be distinguished microscopically from the normal living bone of the host.

In cases where the graft was transplanted to an animal of the opposite sex there was no rehabilitation and the graft was absorbed.

Two clinical cases of the transplantation of alcohol fixed bone into the shafts of long bones are reported. In one of the grafts was a segment of the shaft of the humerus 11.5 cm. long. Both were successful.

Christophe feels that resorption of grafts is a serous phenomenon in which the osteoclasts have no part. There is a general dissolution of the calcium salts and ossein (the organic matrix of bone) by the plasma. The function of the osteoclasts is local absorption or canalization of growing bone. Likewise the formation of new bone is not accomplished by osteoblasts but is accomplished by an extracellular precipitate of ossein which is in the early stages acellular. In some unknown manner this ossein withdraws calcium salts from the bone and becomes bone. This theory of bone formation is similar to that of Heitz-Boyer.

The paper is illustrated by numerous photomicrographs. The idea of the persistence of the graft and its repopulation by living cells from the host is very different from what we believe happens even in living autogenous grafts. The work is of fundamental importance and deserves repetition and confirmation.—*J. Albert Key, M.D., Baltimore.*

THE TREATMENT OF CONGENITAL PSEUDARTHROSIS BY OSTEO-PERIOSTEAL GRAFTS. C. Dujarier and M. Perrin. *Jour. de Chir.*, 21, 401, 1923.

Five cases of persistent non-union of fractures in young children are reported. All were treated successfully by the osteo-periosteal graft of Delagénière. The authors recommend this method for these notoriously difficult cases because they believe that it succeeds more often than does the rigid Albee graft, and being composed of a very thin strip of bone and periosteum it does not weaken the opposite leg as do the free Albee grafts or the pedunculated grafts of Reichel. The Delagénière grafts grow rapidly.—*J. Albert Key, M.D., Baltimore.*

RESEARCHES ON GRAFTS OF EMBRYONIC BONE. R. Simon and M. Aron. *Archives Franco-Belges de Chirurgie*, July, 1922, 25, No. 10, p. 869.

The authors review the scanty literature on the transplantation of embryonic bone and give the results of their own experiments. Under aseptic conditions they removed the long bones from guinea pig foetuses of 70 to 105 mm. long and transplanted them immediately into young or adult guinea pigs. They were usually placed in the subcutaneous tissue of the back and were removed and studied after periods varying from 15 days to 3½ months. The gross and microscopic changes are given in detail.

In the cases in which isolated bones stripped of the surrounding muscles were transplanted, the graft underwent a slow evolution which eventually resulted in the death of all of its constituents, just as does a graft of adult bone which is absorbed and replaced by new bone. In the grafts of embryonic bone, however, the evolution is more slow than in the grafts of adult bone and is often preceded by proliferation of the epiphyseal cartilage cells with temporary thickening of the epiphysis, and occasionally of the shaft from periosteal proliferation.

In the cases where two adjacent bones with the joint were transplanted en masse, the joints subluxated, but mobility was preserved and the degeneration was so slow that grafts were little changed after three months.

In a few cases the skin only was removed and the entire limb was transplanted. In these, after four weeks, the bones were definitely longer and thicker and preserved their normal proportions. The authors attributed this to the mechanical effects of the transplanted muscles, which retained their cross striation and appeared to be living.—*J. Albert Key, M.D., Baltimore, Md.*

VERTEBRAL AFFECTIONS.

LOW BACK PAIN. R. Wallace Billington. *Southern Med. Jour.*, June, 1923, p. 478.

Author concludes that if one does not find consistently guarded movements, definite limited motions of lumbar spine, or persistent and consistent faulty attitude or deformity, there can be little, if any, disability due to the alleged injury or disease of the spine or sacro-iliacs.

He gives five definite causes for low back pain: (1) trauma, including strains, sprains, fractures, dislocations, etc.; (2) faulty posture, with relaxed ligaments and muscles; (3) diseases of the spine and sacro-iliac joints; (4) intra abdominal and pelvic pathology; (5) skeletal malformations, defects, and deformities. Treatment is not discussed.—*F. G. Hodgson, M.D., Atlanta, Ga.*

SACROILIAC ARTHRCS'S OBLITERANS. By Edward S. Blaine, M.D. *Am. Jour. of Roentgenology*, March, 1923.

Blaine presents facts acquired from 1800 cases, 18 of which present unusual changes in the sacroiliac joints. Symptoms enumerated are—"dull pain, soreness and stiffness of the back, with uncomfortable feeling in the lower spine," coming on gradually, progressing for several months to a year or more. Incipiency indefinite, movement of spine restricted. Pathology and etiology not stated except that it is an infectious osteo-arthritis.

Joint changes—destructive and constructive progress, joint cartilage is absorbed, joint is fused and joint lime disappears.

In his X-ray differential diagnosis, he mentions septic arthritis. This condition is undoubtedly a septic arthritis and of the hypertrophic osteo-arthritic type. It is not necessary to differentiate this from tuberculosis of the sacroiliac joint.—*William Jackson Merrill, M.D., Philadelphia, Pa.*

SPONDYLOLISTHESIS. S. Kleinberg. *Annals of Surgery*, April, 1923, p. 490.

In this article, the author emphasizes three points: (1) the condition occurs more frequently in males than we have heretofore believed; (2) the lesion presents a radiographic appearance which is pathognomonic, and (3) trauma is frequently the direct cause, or at least, a very important factor, in its etiology.

The fifth lumbar vertebra is tilted forward so that its superior surface is directed upward and forward. This inclination has been assumed to be a weak point in its relationship with the sacrum. The radiographic appearance of the lumbo-sacral region varies according to the location of the X-ray tube in relation to the last lumbar vertebra. In a normal spine the lumbar vertebrae all appear as quadrilateral shadows in an antero-posterior view if the central rays pass through the lumbo-sacral region. If the tube is opposite the dorsal region all the lumbar vertebrae appear rectangular except the last one. The area occupied by the fifth is diminished and one sees two oblong masses joining medially at an obtuse angle. In spondylolisthesis, with the last lumbar vertebra dislocated anteriorly, in a front view of the patient we are looking at the superior surface of the last lumbar vertebra, and this condition can be detected in an antero-posterior X-ray. A lateral view will clinch the diagnosis, but in the very obese this is difficult or impossible to get.

It has been argued that such a severe lesion could hardly be the result of the degree of trauma usually mentioned by these patients. Probably these patients have an anatomical or developmental defect in this region, but there is evidence to support the idea that trauma is the primary etiologic factor.—*William R. Smith, M.D., Atlanta, Ga.*

THE TREATMENT OF PAINFUL AFFECTIONS INVOLVING THE CERVICAL VERTEBRAE. Harry Leslie Langnecker, M.D. *California State Journal of Medicine,* January, 1923.

In making a survey of a large number of private and clinic cases, the author divides the affections involving the cervical vertebrae into the following classifications:

Group I. Severe injuries and inflammations in which immobilization and fixation were used.

Group II. Arthritic cases in which a search for infectious foci was carried out.

Group III. Cases complaining of pain in the neck in which after radiographic examination no evidence of organic disease was found and the patient was told to "forget the pain in the neck."

This failure to recognize and treat these defective posture cases frequently leads to permanent disability and often causes the patient to try measures which may retard recovery and which may prove harmful.

After a correct diagnosis is made, treatment should be given to restore function to a maximum degree or prevent increasing disability.

Treatment should be directed toward elimination of infectious foci, correction of postural conditions, rest by complete or partial fixation, improvement of muscular and ligamentous tissue tone by active hyperaemia. Movement should be attempted early while still in fixation stage, and carefully selected active exercises should complete the treatment.—*C. L. Lowman, M.D., Los Angeles, Calif.*

BACKACHE AS A CAUSE OF CALCAREOUS DEGENERATION OF THE DORSAL AND LUMBAR AORTAE. John Ridlon and Elven J. Berkheiser. *Journ. A. M. A.,* June 23, 1923, p. 1831.

The authors believe that a certain portion of the very large numbers of painful backs for which one cannot account are due to circulation changes: changes that give loss of expansibility and contractibility and hence to ischemia of the musculature, calcareous degeneration in both the thoracic and the abdominal aorta without other roentgen ray evidence of pathologic conditions of bone or joint. For years, we have known that circulatory disturbances were associated with muscular pain and stiffness. Since it has become generally recognized that discomfort in the feet is due to an impaired circulation, we have thought it fair to assume that discomforts in other parts of the body as well may be due to impaired circulation in the muscles of the particular part. Bone spurs are a cause of sensitiveness to pressure, and, when in close relation to joints, to movement; but they are not a cause of pain: pain is due to the circulatory changes. In the same way in the back, bone spurs and bridges cause sensitiveness and stiffness, but it is the circulatory changes that are responsible for the pain. The authors recommend an examination of the circulatory system in painful back conditions. Many of such cases should be treated by the internist. Girdles, braces, plaster jackets, and extensions should not be employed as a routine. Three case histories accompanied by roentgenograms are included in the paper. *E. Z. Holt, M.D., Atlantic City, N. J.*

KOEHLER'S DISEASE AND LEGG-PERTHES' DISEASE.

KOEHLER'S DISEASE AND PERTHES' DISEASE. G. Axhausen. *Zentralbl. f. Chir.*, Apr. 7, 1923.

Author has repeatedly contradicted the traumatic etiology of this affection and has regarded the impression of the plantar joint surface not as a fracture of normal bone but as a pathological, spontaneous fracture of necrosed bone tissue. Researches on abundant material in the various stages of development substantiate his opinion and complete the picture of the entire course of this disease.

In the very early stage only the epiphysis undergoes *aseptic necrosis;* no loss of continuity of bone and therefore no X-ray changes as yet demonstrable. The accompanying regenerative processes arise from the neighboring metaphyseal periosteum which proliferates in exuberance, so that bone stores up on the outer surface of the shaft. At the same time, the proliferating periosteal connective tissue breaks through the joint cartilage and expands in the marrow space of the dead epiphysis. This break of continuity of the joint cartilage, together with the bone atrophy of the epiphyseal base, robs the dead epiphysis of its firmness; the weight bearing on this weak, dead, and bloodless point of support causes the fracture on the plantar joint surface.

In the second stage of development, to the above picture of necrosis and bone proliferation is added a superficial impression-fracture of the dead epiphysis on the plantar joint surface. The X-ray presents the shadow of a light flatness of the epiphysis with a faint and even condensation of the bone and a slight thickening of the metaphysis. The peculiarity of this pathological fracture is that it involves only necrosed bone, being bordered by dead bone and dead marrow. The healing of such a fracture is an impossibility. Instead of that, the dead fractured bone crumbles and grinds to a powder with each step, and bone flour and crumbs fill the space of the fractured ends and the marrow cavity. The young connective, richly vascular tissue which spreads from the cartilage-bone edge and, later, from the metaphyseal marrow into the marrow cavity of the dead epiphysis, finds resistance in this bone-splinter-wall and cannot, therefore, substitute the fractured bone pieces. It only forms connective tissue layers about this mass of bone splinters.

In the third stage we find, histologically, a piece of dead bone in the subchondral region on the plantar surface. This dead bone encloses dead marrow and is separated from the rest of the epiphysis by means of the bone-splinter-wall and a thick layer of young and old connective tissue which contains numerous giant cells. The X-ray shows now, in addition to the previous shadows, condensed bone shadows, appearing like sequestrae, within the epiphysis. The final stage is an outspoken arthritis deformans with its deforming joint surface, synovial hyperplasia and hypertrophy of the bone edges. Fracture is a frequent sequel of the epiphyseal necrosis, but it may not necessarily occur in each case.

The described histologic findings hold good in the development of Perthes' disease. In both conditions the X-rays are negative in the early stage; in both cases the same changes occur in the course of their development—flattening of the joint surface which appears compressed; condensation in patches which are surrounded by light areas; thickening of the metaphysis and, finally, malformation of the joint end. Proof that both processes are analogous has been substantiated by the his-

tological examination of a specimen, epiphysis of the femur, of an early case of Perthes' disease (reported by Dr. Fruend at the last surgical congress). The findings correspond to the second stage of Koehler's disease. It is beyond doubt that both diseases are of the same nature—aseptic epiphyseal necrosis as a base. The weight bearing upon dead bone and the accompanying regenerative process results, in both instances, in a joint which may rightly be designated an arthritis deformans. The histological pictures and the mode of development of these diseases do not lead to the factor of the primary necrosis of the epiphysis; it, however, excludes trauma as a reason for these malformations.—*A. Gottlieb, M.D., Los Angeles, Calif.*

ETIOLOGY OF KOEHLER'S DISEASE. Duerig. *Muench. Med. Woch.*, March 23, 1923, p. 362.

In the various reports of Koehler's disease the foot configuration is unfortunately not always mentioned. The condition of the foot under weight-bearing is disregarded in most instances, although it is undoubtedly a fact that flatfoot and depression of the anterior arch may usually be disclosed. A few cases, including the one reported in this article, substantiate these findings. The reason why the second metatarsal is affected can be explained through the inefficiency of the muscular-ligamentous apparatus in faulty and excessive weight-bearing which leads to a pes transverso-planus. In the latter, the second and, at times, the head of the third metatarsal is depressed and suffers trauma with each step. On this basis can also be explained the "marching fractures" of the second and third metatarsals.

The existence of the so-called marching fractures on the second and third metatarsals and the phenomenon named Koehler's disease on the second, rarely on the third metatarsal, leads to the presumption that both affections may have a similar etiology, viz.—faulty statics and excessive weight-bearing.

The reported case seems to prove this supposition.—*A. Gottlieb, M.D., Los Angeles, Calif.*

SEPARATION OF THE UPPER EPIPHYSIS OF THE TIBIA. Alexander Gibson, *Annals of Surgery*, April, 1923, p. 485.

Diastasis, or epiphyseal separation, is an accident that is possible only in adolescent life or late childhood. It is rare before the age of twelve. While any epiphysis may be the seat of this injury, the most frequent sites are the lower epiphysis of the radius and the upper epiphysis of the humerus.

While separation of the lower epiphysis of the femur and partial separation of the tongue-shaped process of the upper tibial epiphysis are fairly common, separation of the upper epiphysis of the tibia itself is rare, and detachment of the upper fibular epiphysis alone is unrecorded.

The usual history in the cases of upper tibial diastasis is of a violent wrenching of the leg, together with abduction or adduction. Some writers believe that direct pressure against the epiphysis is the chief factor. The clinical picture suggests backward dislocation of the knee at first sight, but this can be ruled out by the age of the patient, exact interpretation of bony points, and X-ray.

Based on cases reported to date, the prognosis in these cases is not particularly reassuring. The author quotes a series of 24 cases mentioned by Poland, in 12 of which the patient died or the limb was amputated. Shock and septic infection play an important rôle in this condition. If no serious complication arises, however, and reposition is exact, prognosis regarding growth is very good.—*William R. Smith, M.D., Atlanta, Ga.*

Isolated Disease of the Scaphoid. Barclay W. Moffit, M.D. *Journal A. M. A.*, January, 1923.

The condition is important because it has been mistaken for tubercular disease. It was first described by Koehler in 1908.

It occurs in children, from 4 to 8 years of age, and causes a slight limp, pain, tenderness, and enlargement of the bone to the palpating finger.

The etiology is unknown. Trauma has frequently preceded the disease and seems the most likely causative factor, though not the direct cause, perhaps acting through injury of the center of ossification or by tearing nutrient vessels or exciting a dystrophy.

The X-ray shadow of the bone is much smaller than normal. It occupies, however, the same space as a normal bone and the arrangement of the other bones is not altered.

The prognosis is good.

The treatment is rest or immobilization for three to ten weeks.

The author concludes that the scaphoid becomes enlarged because of trauma, and undergoes a compression fracture through weight-bearing because of this enlargement.—*C. L. Lowman, M.D., Los Angeles, Calif.*

MISCELLANEOUS.

Case of Cubitus Varus. A. Contargyris. *Revue d'orthopédie*, March, 1923, p. 161.

The author reports a case of a soldier, who, at the age of six years, fell and suffered a cubitus varus deformity of the left elbow. Flexion is slightly limited; also extension, but pronation and supination are normal.

From the point of view of pathogenesis, the author thinks that his case supports the osteogenic theory of Rieffel, by which he explains both the mechanism of cubitus varus and its symptoms. The osteogenic theory in this case has in its favor: (1) the age (6 years) of the patient at the time of the traumatism; (2) the appearance of the deformity after the apparatus was discontinued; (3) the radiographic findings—no irregularities, but atrophy of the trochlea and lack of union of this with the humeral epiphysis at the age of twenty-four, that is, eighteen years after the traumatism.

INFLAMMATION OF THE DEEP CALCANEAL BURSA. A. E. Hertzler. *Jour. of the Am. Med. Assn.*, 81, No. 1, 8, July 7, 1923.

The author describes an inconstant bursa lying beneath the abductor hallucis muscle. Inflammation of this bursa causes pain and tenderness in the front part of the heel, just anterior to the attachment of the flexor muscles. The usual signs of flat foot are absent. Cure is obtained by curetting and draining the bursa through a small incision below and in front of the sustentaculum tali.—*J. Albert Key, M.D., Baltimore.*

SOME LESS FREQUENTLY CONSIDERED PORTALS OF INFECTION IN ARITHRITIS AND IRITIS. Ernest E. Irons. *Journ. A. M. A.*, June 30, 1923, p. 1899.

Less frequently considered portals of entry of recurrent infections: (1) mucous membrane of upper respiratory tract; (2) tissues about hila of lungs; (3) intestinal tract. The problem is evidently concerned with (1) the passage of bacteria through the stomach and their fate in the small and large intestine; (2) the permeability of the mucosa of the intestine for small particles and for bacteria, and (3) the survival of these bacteria in the lymphatics, lymph nodes, and blood, and their subsequent lodgment in the eyes, joints, and other structures. These are numerous case reports of iritis associated with gastro-intestinal upsets, constipation or diarrhea, in which healing of the iritis has apparently been hastened by treatment directed toward the intestinal tract, either by laxatives or by modifications in diet, with the elimination or reduction of proteins, fats, or carbohydrates. The satisfactory demonstration of direct invasion through the intact intestinal mucosa of man by organisms which can cause arthritis without continued general infection presents difficulties that so far have not been overcome. That the intestinal tract may sometimes be the portal of entry of recurrent metastatic infection seems certain. *E. Z Holt, M.D., Atlantic City, N. J.*

TRANSPLANTATION OF THE TENSOR FASCIAE FEMORIS IN CASES OF WEAKENED GLUTEUS MEDIUS. Arthur T. Legg. *Journal A. M. A.*, January 27, 1923.

Describes the limp caused by a weak gluteus medius, and calls attention to the action of this muscle in keeping the body from falling to the opposite side when the weight is borne on one leg.

Gives the technique of the operation, which frees the tensor fascia with a portion of the fascia lata into which it is inserted, and implants this insertion of the muscle into the outer surface of the femur, about two and a half inches below the great trochanter, under an osteo-periosteal flap. The leg is put up in a plaster spica with thirty degrees of abduction.

The after treatment includes walking in the spica, and muscle training after four weeks, and the substitution of an abduction walking splint after two months, which is worn for six months.

Reports fifteen operations, with very satisfactory results.

Specifies that selection of cases for this operation should exclude those in which the limp is due to weakness of both gluteus maximus and medius, and those in which it is due to weakened lateral abdominal muscles.

The author believes the operation will give increased muscle support to the hip joint and so tend to prevent dislocations from weakened muscles around it.—*L. C. Lowman, M.D., Los Angeles, Calif.*

ANATOMIC FORMS OF FLAT FOOT. Nové-Josserand. *Revue d'Orthopédie,* March, 1923, p. 117.

By means of the X-ray findings flat feet are divided into simple, congenital, and those due to calcaneo-scaphoid synostosis. The simple flat foot is described as an adduction and pronation of the posterior tarsals with the scaphoid accompanying the head of the astragalus in its descent, but subluxating laterally to cause a valgus deformity of the fore foot. In the four congenital cases reported in this paper the lowering of the head of the astragalus is more marked (170 to 180 degrees as compared to a maximum of 145 degrees in the acquired type), and the scaphoid and cuboid tend to subluxate upwards and carry the fore foot into dorsiflexion. Two cases are reported with an apophysis springing from the anterior superior part of the os calcis and articulating with the scaphoid. The displacements are those of acquired flat foot but require more radical treatment.—*J. Albert Key, M.D., Baltimore.*

HEMORRHAGIC OSTEOMYELITIS: REPORT OF CASE. Max Strunsky, *Journ. A. M. A.,* June 23, 1923, p. 1833.

Incorrectly diagnosed by good surgeons for six months. Operation:—A large cavity filled with viscid degenerated bloody material was found. Cavity was evacuated, walls curetted and painted with alcohol and iodine. Incision was enlarged over entire length of tibia. Entire crest of tibia was removed with circular saw. The graft was cut into fragments and dropped into the cavity. Only 1/3 of cavity was filled. The skin was sutured and patient made an uneventful recovery. It took 18 months for complete regeneration of bone. The author recommends radical surgery in such cases. In this case the fragments acted as a bridge over which new bone grew. The symptoms in this case preceded for some time the roentgenologic appearance of bone liquefaction and absorption. One should be on guard when trauma is followed by an apparent recovery and followed again by symptoms. *E. Z. Holt, M.D., Atlantic City, N. J.*

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